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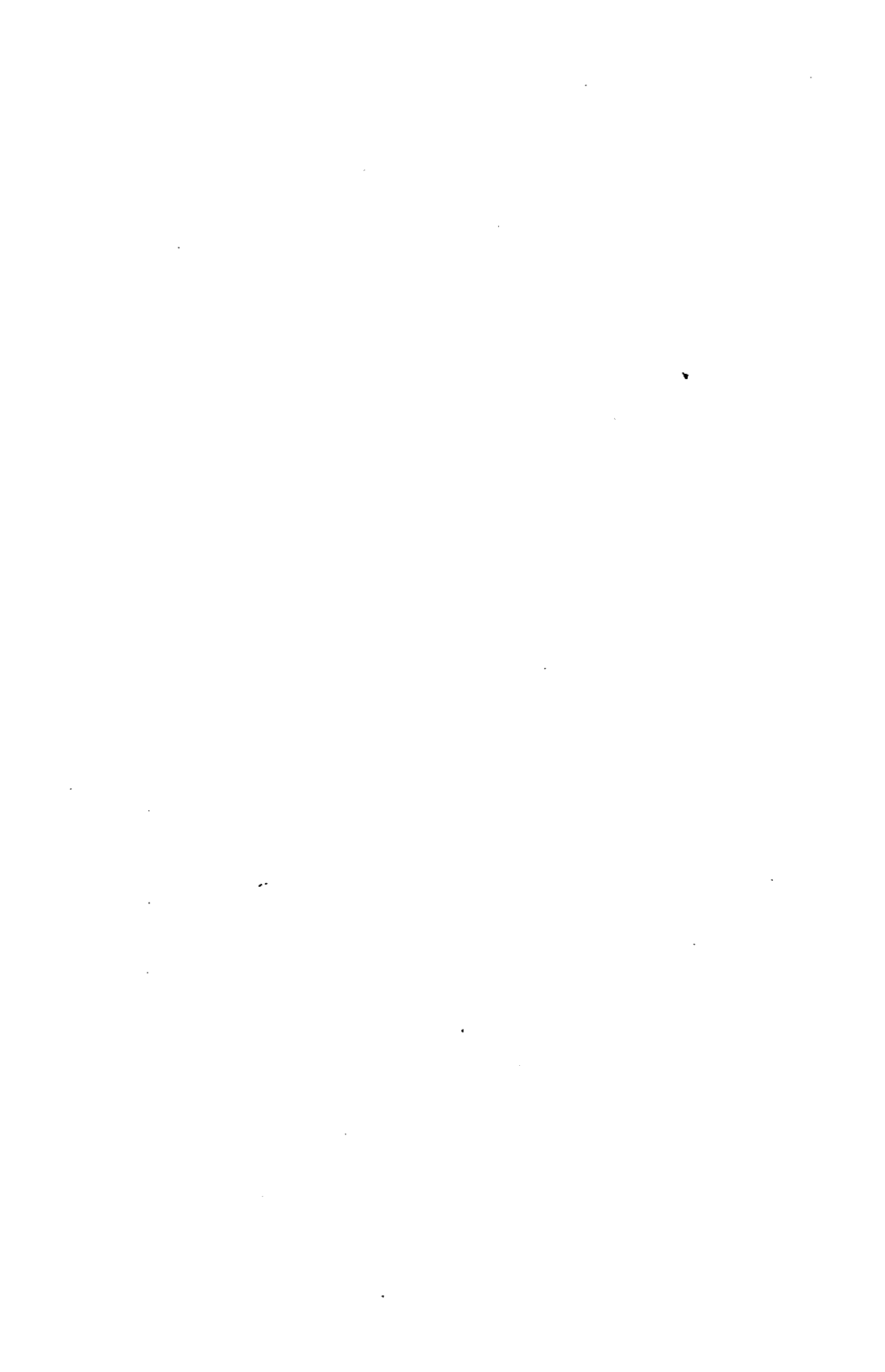


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THE CLASSIFICATION
OF THE
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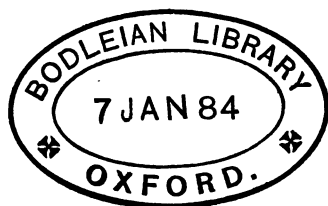
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THE CLASSIFICATION
OF THE
CAMBRIAN AND SILURIAN ROCKS.

BEING
THE SEDGWICK PRIZE ESSAY FOR THE YEAR 1882.

BY
JOHN E. MARR, M.A. F.G.S.
FELLOW OF S. JOHN'S COLLEGE.

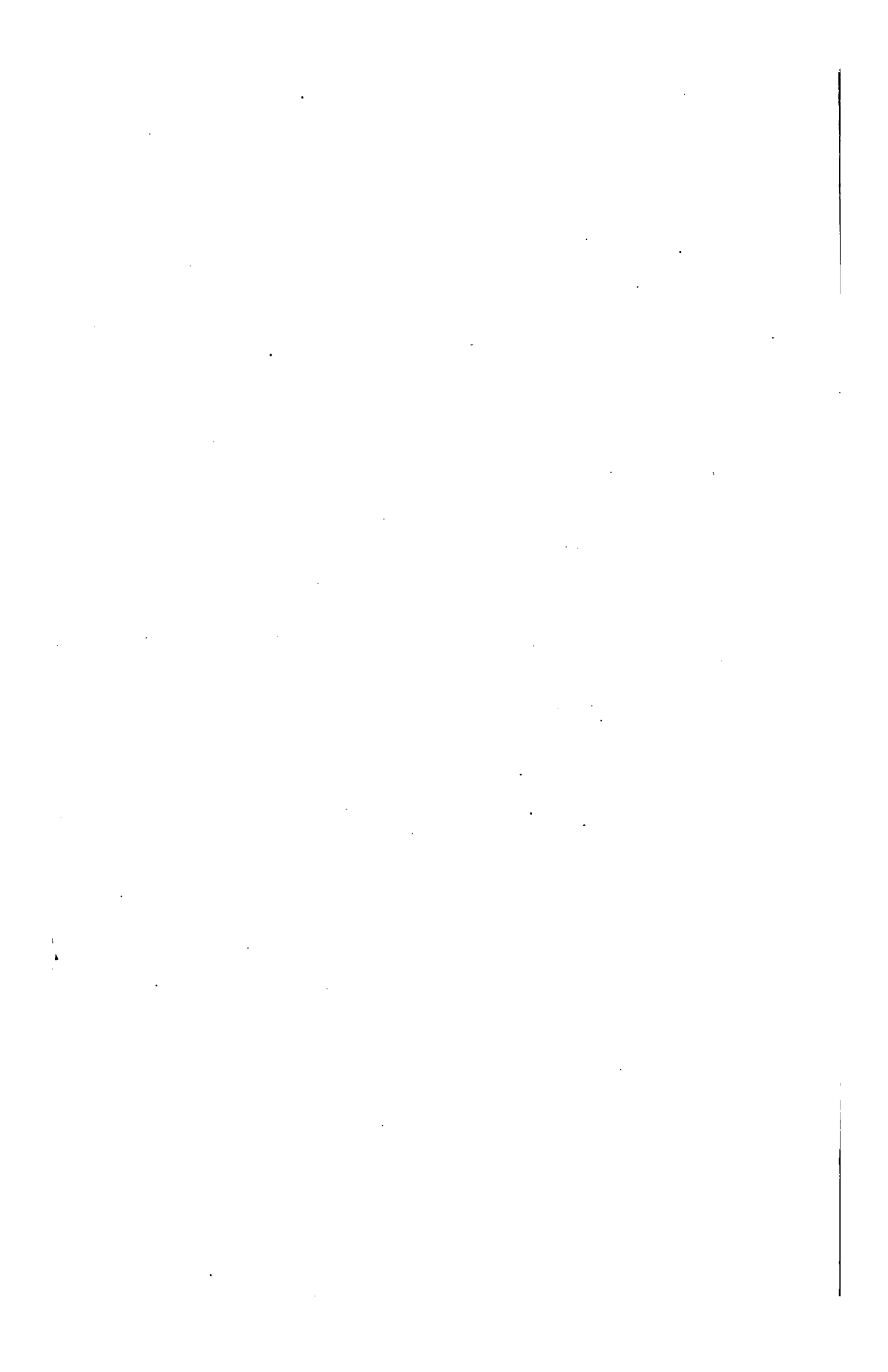
CAMBRIDGE:
DEIGHTON, BELL AND CO.
LONDON: GEORGE BELL AND SONS.
1883



PREFACE.

THE classification of our rocks is in great part historical, the names adopted for the various subdivisions being those given by the geologists who defined the subdivisions. In the case of the Cambrian and Silurian rocks, there are some who wish to abandon the historic classification in favour of one which they consider to be more natural. The object of this essay is to shew that the historical classification of the Cambrian and Silurian systems is also in reality the natural one, and that this cannot be said of any other nomenclature proposed. In order to do this, I have given a somewhat detailed account of the subdivisions of the two systems, in the countries where they are best known, so that the horizons where breaks have been drawn by different geologists may be compared with those of the typical areas of our own country. With the view of rendering this still easier, lists of fossils occurring in the various groups have been given, which though by no means exhaustive, may nevertheless be found useful, being chiefly characteristic of the horizons under which they are placed.

I have avoided giving tables shewing the percentage of fossils common to two subdivisions, as I consider that in the present state of our knowledge such tables are apt to be misleading, as the result obtained depends very much upon the method employed in drawing up such tables.



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§ I. *Introduction.*

SINCE the year 1831, memorable in the history of the Lower Palæozoic rocks as the date when Sedgwick and Murchison independently set to work to unravel their structure, and to establish two systems from out of the confusion of the Greywacke, every year has added afresh to our knowledge of these rocks; but notwithstanding the numerous detailed accounts published, we are still far from possessing any definitely accepted nomenclature.

As is well known, this confusion originally arose, on account of errors committed by the founder of the Silurian System,—in the words of an American geologist and an impartial judge, “The Silurian System of Murchison was altogether incorrect, and was moreover based upon a series of stratigraphical mistakes which are scarcely paralleled in the history of geological investigation.”

Yet, rather than assign to the Silurian System, only those subdivisions to which Murchison was entitled to lay claim, geologists have been content to see absorbed into it one after another of the subdivisions of that grand natural system which was built up single-handed by Sedgwick, until either the whole of it has been thus taken, or a few hundred feet of slate only left as a tribute to the genius of the founder of the Cambrian System.

For many years the claims of our late Professor were ignored, or at most passed over on the ground that it was too late to adopt his classification, as that of his opponent was now definitely accepted. Of recent years however, compromises have been offered which have had one beneficial result, viz. that of throwing the nomenclature of the lower Palæozoic rocks

into a state of confusion ; and it is difficult to see how this state of affairs can be altered, except by the adoption of the true historic classification, which is accordingly being done by an ever increasing number of geologists.

Sir R. I. Murchison, as the Director General of the Geological Survey of Great Britain and Ireland, was enabled to get official recognition of his classification, and took full advantage of this ; it therefore behoves Cambridge geologists to use every effort towards the final establishment in its original state of the Cambrian System of the late illustrious Woodwardian Professor.

Before proceeding to a full account of the results of the various classifications proposed, it will be of advantage to consider briefly the principles of classification, as used by our geologists.

The essence of these principles is thus given by Sedgwick himself in his 'Introduction' to the *British Palæozoic Rocks and Fossils* :—"The rocks of England are now so well known that a pretty good classification of them (from oldest Cambrian to newest Tertiary) might with a few exceptions, be made on physical evidence alone. In like manner (so soon as the long succession of physical groups is known, and the palæontological evidence has been put into coordination with it) an approximate classification of the whole English series might be made on purely palæontological evidence. One would represent a vast succession of physical conditions—the other a similar succession of organic types ; and each might have its appropriate nomenclature. Nature has been so true to her workmanship, that the two would, with a few exceptions, run harmoniously together. But in the actual state of our information, we have done well constantly to use both kinds of information (physical and palæontological) : and in both together has our best, and our only consistent and secure nomenclature been founded. If it be true that experienced geologists have sometimes, from the neglect of palæontology, blundered in the arrangements of the physical groups ; it is equally true that very expert palæontologists, from some mistake of arrangement among the physical groups have sometimes blundered in their palæontology. The

double kind of evidence above described has seldom been lost sight of with impunity."

Since the above was written, several attempts have been made at different times to classify portions of our British Series on palæontological evidence only, and some of the difficulties incurred by such an attempt will be presently pointed out. But in the first place it may be remarked, that of the two kinds of evidence, the physical is decidedly the more important, because after all, palæontological change is dependent upon, and must therefore be accompanied by physical change, it is in fact the result of physical changes acting upon organisms.

The physical changes which are of importance as assisting classification are as follows:—

1. Elevation and Denudation, which give rise to

(a) Unconformities between two groups of rocks.

(b) The formation of shore-deposits as conglomerates.

(c) Variations of strike: when two groups have different strikes, the older group has been affected by elevatory forces which have not affected the newer.

2. Change of Lithological Character. This proves that two groups of rocks have been accumulated under different conditions, and when the conditions are thus proved to have differed greatly during the accumulation of two different groups of rocks, these groups may be separated as two distinct systems, *e.g.* the Jurassic rocks of Britain are separated from the New-Red Sandstone for this reason, although there is no physical break between them, but the difference of lithological character proves that whereas the rocks of the one were accumulated in confined seas, those of the other were deposited in the open ocean.

3. Cleavage. When a lower group of rocks is cleaved, and an upper one not, or if the lower group possesses a double cleavage, and the upper only a single cleavage, it may indicate that the lower group suffered compression before the formation of the upper one: this evidence must be received with caution, as the upper group may consist of rocks which are of such a

character as not to become cleaved; on examining large groups however, we generally find some fine-grained rocks occurring which are well adapted for cleavage, as for instance in the Lake District, where many of the Cambrian and Silurian rocks are too coarse to have admitted of cleavage, but we find fine beds in the Cambrian rocks which have a double cleavage, and other fine-grained rocks among the Silurians, which however only possess one cleavage: in this case it is probable that the Cambrian rocks received one cleavage before the deposition of the Silurians, and that another cleavage was formed in them simultaneously with the production of the single cleavage in the Silurian rocks.

4. Metamorphism. When a lower group of rocks is regionally metamorphosed, and an upper one not, or when the lower is more intensely metamorphosed than the upper, it probably indicates the alteration of the lower group before the upper was deposited. This in turn shews that the lower must have been covered by much sediment before metamorphism, in order to bring it under the influence of metamorphic agents, and that this sediment was denuded before the deposition of the upper group. Examples of this are furnished by the slightly metamorphosed Pebidian rocks of Wales resting upon the greatly metamorphosed Dimetian, and the unaltered Cambrian rocks upon the Pebidian. (The term "unaltered" being applied with reference to true metamorphism, and not to cleavage.)

The palæontological changes are produced:

1. By Elevation and Depression of Land.
2. By changes of Temperature, Food, and other Conditions.

Such causes produce breaks in the succession of organic life, and migration. Breaks in succession are partly purely physical, owing to the denudation of the rocks containing intermediate forms, and partly due to migration of forms, and subsequent return into the original area, after having undergone important specific or even generic modifications during migration and the occupation of other habitats. When these two occurrences have both taken place between the deposition of two groups of rocks,

the change so caused is of considerable classificatory value. But migration may take place, not only by elevation of the ocean-floor, but also by depression, and in this case the depression may also cause a pause in the deposition of material, so that by this means a difference in the forms of life is observable on comparing the beds immediately above with those immediately below a plane of stratification. Such a break does not indicate so important a series of changes as does one accompanied by denudation, and for this reason is not of so great classificatory value. Moreover, if the theory be true, which is gradually gaining ground, that our present ocean basins have been, speaking generally, permanent through long geologic ages, whereas our continental areas have been the sites for the most part of great elevatory movements, the occurrence of palæontological breaks owing to extreme depression will be comparatively rarely found in those rocks which compose our continental areas, and this reason likewise diminishes the value of this kind of palæontological change as an aid to classification.

The most valuable palæontological changes then are those which are due to elevatory movements, and it will be found that these are in some cases very widely spread. Of late years, classifications of some of our older rocks have been attempted, by taking into account the palæontological changes produced by depression, but these are not capable of being traced over wide areas, and consequently the adoption of such classifications would cause a considerable amount of confusion. It is evident that palæontological change is of very considerable importance to us, but that it must be, as stated by Sedgwick, considered along with the physical evidence. To shew how extremely unsafe it is to rely on palæontological evidence alone, some of the difficulties incurred may be enumerated :—

1. In considering the relative importance of the breaks between different groups of rocks, palæontologists may be influenced by very various circumstances :—

- i. Some might calculate the number of genera in two different groups of rocks, and then estimate how many genera are common to the two groups.

ii. Others might calculate the number of species, and estimate how many species are common to the two groups.

iii. Others again might omit certain forms (as the Protozoa) as being too lowly organised, or other forms (as the Vertebrata) as being too highly organised to yield true results.

iv. Again, others might prefer to estimate the forms of some particular zoological group (e.g. the Mollusca) which are common to the two groups of rocks.

v. Moreover, the break may be calculated, by observing the number of genera or species,—or of genera or species of some particular sub-kingdom or sub-kingdoms which are common to the highest series or stage of a system, and the lowest series or stage of the next succeeding system. In this way a break has been drawn between the Tremadoc and Arenig rocks of Britain (thereby making one the highest division of one system, the other the lowest division of another system). The results of such a proceeding may be totally altered by separating off the lower portion of the lower series, or the upper portion of the upper series to form different series: thus if the upper part of the Arenig be separated off from the rest of that series, as suggested by Dr H. Hicks, to form another series, the Llanvirn, the break between the Tremadoc and the Arenig will thereby be much less than if the rocks thus separated were left in the Arenig, because most of the species common to the two series will occur near the boundary, whilst most of those which are peculiar to the undivided upper series will naturally occur in its upper portion.

2. The number of species common to two systems will probably be exaggerated owing to the occurrence of remanié forms derived from the denudation of the rocks of the lower system, and occurring in the basement beds of the upper system. Instances of this are familiar in the case of the Cambridge Greensand which contains fossils of Gault age, although the bed itself is in reality the basement bed of the Chalk. In this case it is easy to see that the fossils are derived, owing to the undisturbed character of the beds, and the difference in state of preservation of the remanié fossils, and those of the age of the

bed, but in the older rocks, where the fossils usually occur only as casts, and are often much distorted, it would be very much more difficult to distinguish a remanié fossil from one truly appertaining to the bed. To give an example, *Trinucleus Wahlenbergi* is cited in Kjerulf's *Veiviser* as occurring in rocks containing a true May Hill fauna, but on examining the specimen in the Christiania Museum it was found to occur in a nodule such as might easily have been derived from the underlying rocks, and I could find no evidence of any other specimen of the same genus having occurred in this series. Sedgwick noticed the possible occurrence of such forms in the Introduction to the *British Palæozoic Rocks and Fossils*, and says, "On this ground, while we are making a comparative estimate of the Cambrian and Silurian faunas, we can only count at a very low value such species as abound in the lower, and appear *very rarely* in the *upper* division, and appear *there* only within a very little distance of the line of demarcation between the two."

3. Fossils are recorded as occurring in systems or series in which they are not really existent, owing to two reasons.

(a) Certain beds belonging to a system *A* were at one time supposed to belong to another system *B*, and consequently the fossils they contain are quoted in various lists as occurring in system *B*, and on the ascertainment of the true positions of the beds, some of the forms which have thus wrongly been quoted in the lists as occurring in system *B*, are inadvertently left in the lists of fossils of that system. As an illustration of this I may refer to the recording of *Paradoxides* in certain lists both as a Menevian and a Lingula Flag fossil, these being really records of the same individual specimens, and being due to the fact that the Menevian was once included under the term 'Lingula Flag,' and since separated.

(b) Field geologists sometimes form fossil-lists of a series which contain wrong determinations, owing to their having been noted down in the field, without comparison of the specimens collected, with type forms, or figures and descriptions, and so the number of fossils apparently common to two different systems may be increased.

The history of the so-called Llandeilo series affords an excellent instance of the way in which a single stratigraphical mistake has given rise to great confusion among the fossil lists, but to this reference will be made in the sequel. I shall content myself here with again quoting from Sedgwick's Introduction to the *British Palæozoic Rocks and Fossils*—"Without dwelling on cases of *immediate ambiguity*, we may affirm generally—that when we profess to give a comparative estimate of the Fauna of any two Palæozoic groups, we have no right to overlook the question, whether certain species belong to a prevailing type in one of the groups, or, on the contrary, are rare (and perhaps doubtful) exceptions. I will take for example, six species which are given by the author of *Siluria* as common to the Llandeilo, Wenlock, or Ludlow formations, viz.:—*Tentaculites annulatus*, *Petraia elongata*, *Trinucleus concentricus*, *Leptæna sericea*, *Orthis Actoniæ*, *Orthis vespertilio*. This list might be largely increased, but I select these six species for a reason given below. In many parts of the Cambrian series they are found in millions: and they produce a very characteristic impress on its Fauna. But not so much as a single unequivocal fragment of any one of them is to be found in those parts of the Cambridge collection which are derived from the May Hill Sandstone and beds above it. Negative facts cannot stand a moment against positive. This we all allow: but if negative facts be honestly and laboriously stated, they *may*, at least, prove that certain positive facts (such as the six examples above quoted of species common to Cambrian and Silurian rocks) are *very rare* and *exceptional* cases. Such cases are not to be received but on evidence that is unequivocal, viz.:—the production of the very species upon which the exceptional lists have been formed. Now I was informed by Professor McCoy (in a note which is now before me) that he had applied, at the Museum of Economic Geology, for a sight of five, out of six, of the very species above enumerated, and that not one of them was shewn to him, or found in the Museum, under conditions which confirmed the assertion that they were common to Llandeilo, Wenlock, or Ludlow rocks. As to one of the six species (*Orthis Actoniæ*) I myself applied to Professor Forbes

for his authority. He replied that he could not give his sanction for this species as a type common to the (so-called) Upper and Lower Silurian rocks—that he had nothing but a field-memo-
randum respecting it, and that he might very easily have mistaken the species, or mistaken the rock from which it was obtained.” Another case may be given where the negative facts are very strong. *Cardiola interrupta* is an abundant fossil at a certain horizon in the Silurian rocks of Britain where it is associated with particular species of Graptolites. It occurs also in the Silurian rocks of Scandinavia, France, Bohemia, &c. associated with the same Graptolites. In the Cambridge Museum there is no single specimen of this species from the Cambrian rocks, and it has not been found in the Cambrian rocks of the countries just enumerated.

It has however been recorded by Profs. Harkness and Nicholson from the Cambrian beds of Westmorland, but these authors subsequently admitted that the Coniston Flags (the beds in which *Cardiola* is found in abundance, and which they formerly included in the Cambrian system) were in reality Silurian. The Lake District rocks of true Cambrian age have been well searched by many geologists, but no other instance of the discovery of *Cardiola interrupta* in these rocks is known to me, save the one referred to above. Nevertheless, in the new edition of Sir A. Ramsay's *Geology of North Wales*, Appendix, p. 413, *Cardiola interrupta* is recorded from the Caradoc rocks of Westmorland. Again in the list of Llandeilo Fossils in p. 391 of the Appendix, *Cardiola interrupta* is recorded from the Llandeilo rocks of both North and South Wales; but on examining the list of fossils from the Llandeilo rocks of North Wales with their chief localities on p. 387, *Cardiola interrupta* is *not* recorded,—yet surely a locality which has yielded a species so noteworthy has claims to be included amongst the ‘chief localities.’ This evidence can hardly be termed unequivocal.

Having reviewed some of the difficulties to be taken into account, when drawing boundaries by breaks in the succession of organisms, the phenomena of migrations may be very shortly considered. Such migrations may be studied in two distinct ways; firstly by observing the recurrence of species in higher

beds, and secondly by observing their lateral movements, recurrence being best observed in deep-water deposits, and lateral movement in shallow water ones. Good instances of recurrence have been given by M. Barrande, as observable in bandes *d. 1*, *d. 3*, and *d. 5* in Bohemia. These recurrences are in fact best observed in beds belonging to the same system, and *we get no marked instances of the recurrence of organisms occurring in one system in beds of the succeeding system.*

Lateral movement may be detected by finding organisms (usually inhabitants of shallow seas) later in one area than in another, e.g. the migration of a few forms may be traced from Russia through Scandinavia to Britain in Cambrian times. In early Silurian times the direction of migration seems to have been somewhat altered, and this was apparently due to the great local upheaval of certain British areas in these times: hence a local upheaval not only affects the area in which it occurs, but through the medium of organisms, has an effect upon the surrounding areas also, and if it coincide with a more wide-spread upheaval, may be of some classificatory value.

Sufficient has been said, to shew that in order to separate off systems, physical and palæontological evidence must be considered together, and that there are very grave difficulties to be overcome, when palæontological evidence alone is taken into account. If systems be separated off in this two-fold manner, which is the only true natural way, it is evident that we cannot expect always to find that the various systems should be of even approximately equal size, or that the same system should have approximately the same thickness in different areas: a glance at the thickness of the various systems given in our text-books will at once shew this, and yet objection has been raised to the true historic classification of our Cambrian and Silurian rocks, on the ground that the Cambrian system is very much thicker than the Silurian, in their respective typical areas: is this objection valid? let us examine it more closely.

Sedgwick estimates the thickness of his Cambrian beds, excluding the Longmynd slates at 25,000 feet. He says the aggregate thickness of the Silurian beds is about 5,000 feet; but this excludes a great thickness of red deposits now classed

with the Old Red Sandstone which rests conformably upon the Silurian, and must be eventually included with it.

In the Lake District the thickness of the Silurian beds is estimated by Mr Aveline at not less than 14,000 feet, and it thus compares favourably with the thickness of the Cambrian system of the type area. In Scandinavia both Cambrian and Silurian Systems are very much thinner than in Britain, but are composed in great part of deep water deposits which would accumulate much more slowly than a similar thickness of shallow water deposits. Where shallow water deposits are found they are of considerable thickness. In Bohemia, the Cambrian beds contain not quite three of Barrande's étages, viz.: part of B, and the whole of C and D; the Silurian on the other hand contains four, E, F, G and H. The argument that the Cambrian should be split up into two systems in order to equalise the thicknesses is therefore on the whole untenable.

Objections have been raised to using physical breaks as means of classification on account of their local character; if this means that they are not universal, every one must agree to this, as there must always have been deposits forming somewhere, namely wherever oceanic areas prevailed. Dr Hicks seems to consider it as a creed of the Cambridge School that the break between the Cambrian and Silurian rocks is universal*: I have already referred to the theory of the former permanence of ocean-basins, and the persistence of areas of elevation along what are now our continental areas: and Dr Hicks gives colour to this theory (*Q. J. G. S.* 1875, p. 552), for he considers that the European and North American areas underwent approximately simultaneous changes of like character. "The home of the earliest forms of life seems to have been somewhere towards the south-west, and possibly not far from the equator; and it is from here that the various forms seem to have migrated to the areas in which they were subsequently entombed. The migrations seem to have taken place towards the North-American continent very much about the same time as towards the European; and the sea-encroach-

* See discussion of paper by Dr F. Schmidt, read before Geological Society, June 21, 1882.

ments along that continent seem to have been in a direction from south-east to north-west, so that the lines indicating the two depressions would meet in mid-Atlantic. This accounts for the great similarity in the two faunas, and for the general resemblance offered by the order of succession of these early rocks in the two continents." This general resemblance offered by the order of succession can only be accounted for indeed by supposing upheavals and depressions to have taken place at this time over wide-spread areas, so giving rise to the occurrence of shallow-water conditions about the same time on either side of the Atlantic, and similarly with deep-water conditions. The greatest upheaval in the European area was at the end of the Cambrian period, and we may therefore expect this to have been the case in America also, and this is borne out by facts. The Silurian beds rest unconformably upon the Cambrian not only in Britain, but also in Scandinavia, Bohemia, and parts of North America. We should naturally expect this as a consequence of the phenomena to which Dr Hicks alludes in the above-mentioned passages, and we find it to be the case, but it is not necessary to the arguments of the Cambridge School that a break should occur at the same horizon in other parts of the world as Eastern Asia, Australia, &c., the deposits there having been formed in entirely different oceanic areas probably subjected to earth-movements at different times to the ones which affected what we may speak of as the North Atlantic area, and we should indeed be somewhat surprised to find breaks in those areas at this horizon, and look upon them as accidental coincidences. A word of caution may be here added as to the estimation of the magnitude of a physical break, which must be reckoned not by the amount of unconformability of the strata but by the horizontal extent of that unconformability. Local breaks are often most-marked, and are caused by some violent local earth-movement, or by the accumulation of volcanic material, they are therefore of no great importance; for instance a break is recorded by Mr Aveline at the base of the Coniston Limestone of the Lake District, but this as suggested by Profs. Harkness and Nicholson is due to the overlapping of the Coniston Limestone upon the abraded edges of the volcanic materials of the

Borrodale series, just as limestones may be now formed in the Bay of Naples overlapping and lying unconformably upon volcanic ejectamenta of Vesuvius. In the case of wide-spread breaks, upheaval was more regularly distributed, consequently the land so formed would have a small slope, and this would give a small velocity only to the streams, which would therefore be capable of only a small amount of denudation, and that carried on with a considerable amount of regularity thereby probably giving rise to apparent conformity in some areas where an unconformity in reality exists. Moreover the movement being so widely spread and so uniform, it is quite probable that some areas would not actually be raised above the sea-level and so there would be continuous deposit of material, but the deposits on the horizon occupied in other areas by the break would be of a shallow-water character. It is then not necessary for our argument that an unconformity should occur even in all parts of Europe between the Cambrian and Silurian rocks, but as these rocks have been declared to be conformable in places where unconformities have been afterwards proved to occur, an apparent conformity must not be accepted as actually existent, without very strong evidence.

The classification of our rocks into systems is in fact like the classification of organisms in its general character; it depends upon the occurrence of gaps which will probably be eventually filled up somewhere, but nevertheless it is the only true classification which we can adopt at present, and therefore we must be true to it.

According to the decision of the International Geological Congress held at Bologna in 1881, a system is to be subdivided into series, and these series into smaller subdivisions or stages. This nomenclature will be followed as far as possible in the ensuing pages, but it is impossible at present to adhere strictly to this nomenclature. To take an example: M. Barrande has divided the Silurian rocks in Bohemia into a number of stages, and as the use of this word is here extremely applicable it will be difficult to drop it. Now some of these stages are equivalent to more than one of our larger British subdivisions, which according to the decision of the Con-

gress should be termed series, others again are not so large as one of our larger subdivisions, thus Stage D is apparently equivalent to part of the Lingula Flag, and the whole of the Tremadoc, Arenig and Bala Series of Britain. The Ludlow Series of Britain on the other hand has as its Bohemian equivalents Stages G and H, and possibly a portion of Stage F. The word 'Stage' is also used in a somewhat different sense in Norway by Professor Kjerulf, to that in which it is used by M. Barrande. Stage 5 of Professor Kjerulf is only the equivalent of a small portion of Stage E of M. Barrande. On the whole it will be perhaps best to adopt the word 'series' to denote our greater divisions as Menevian, Bala, &c., which have hitherto been usually spoken of as 'formations' (a decidedly objectionable word as remarked by Professor Hughes in his remarks to the Geological Society upon the work done by the Congress at Bologna, *Q. J. G. S.* xxxviii. p. 2), and to adopt the terms generally used by the foreign geologists for their own particular subdivisions when speaking of them.

A few words may be inserted with reference to the materials of which these series are composed.

The principal series are composed of conglomerates, grits, fine black mudstones or shales, and limestones. The most noteworthy of these are the conglomerates, which frequently contain pebbles many feet in diameter, and the mudstones, which often retain the same character over many thousand square miles of country. The Cambrian and Silurian systems contain no sediments comparable with those now forming in the deeper parts of our oceans; and the calcareous beds usually present indisputable signs of shallow-water origin. I have elsewhere pointed out that the wide dispersal of fine black mud over the Cambrian and Silurian sea-floors was probably due to the fact that they were derived immediately from the denudation of felspathic rocks, and not from ordinary sediments: there is however another cause which may have assisted in this dispersion, and also may account for the remarkable conglomerates, to explain which some geologists have called in the aid of ice-action: this is tidal action, which Mr George Darwin shews to have been much more intense in former times than at

present. Since Mr Darwin published the results of his research, much has been written by geologists concerning the action of these tides, and it is by some considered that they would be intense agents of denudation: it seems to me, however, that no great amount of *disintegration* could be brought about by excessively high tides, but their power of *transportation* would be very much greater than that of the tides at the present time. On submergence of the land, all loose material would be easily carried by the tidal currents, and so beaches would be formed containing fragments of all sizes up to the large blocks like those found in the Cambrian conglomerates of various parts of Europe; but the surface having been denuded of its loose materials, surely the tides would have no very marked effect upon the solid rock. The tidal currents, however, very much more powerful than they now are, would assist in the transportation of the fine felspathic mud brought down by the rivers to great distances from the shore. That the sediment was accumulated any faster than it now is seems to be negatived by facts furnished us by organisms. The rule that a species which has a wide distribution in space has also a long vertical range seems at first sight to be inapplicable to the distribution of most of the Rhabdophora, the same species of which are found at the same horizons over very wide areas, and yet these species are often limited to a few feet or even a few inches of the black sediments in which they occur. The only explanation seems to be that these black sediments accumulated with extreme slowness, and this is borne out by the myriads of individuals which are buried in them, and which must represent long periods of time.

Such being the mode of formation of many of these older deposits, and lithological character being frequently so uniform over wide areas, we can correlate beds widely separated with much greater accuracy than many geologists are disposed to admit.

§ II. *The Position of the Boundary between the Cambrian and Silurian Systems.*

Having described the principles of classification as used by British geologists, when dividing our stratified rocks into great groups, which we now agree to call systems, it remains to apply these principles to the classification of the Cambrian and Silurian strata.

It is not necessary to do more than merely refer to the personal controversy between the late Woodwardian Professor and Sir Roderick Murchison, for no one now denies that the latter made a great mistake and tried to cloak it by claiming as his own the labours of his colleague: this mistake was the assignment of his Llandeilo series to a position far above its true one, and it was increased by his confusion of the May Hill beds with what he termed Caradoc, i.e. beds belonging to Sedgwick's Bala Series. The facts of the case are admirably reviewed by Sedgwick himself in his Introduction to McCoy's *British Palæozoic Rocks and Fossils*; and that to Salter's *Catalogue of Cambrian and Silurian Fossils*, also by Dr Sterry Hunt in the *Canadian Naturalist* for April and July 1872, and subsequently in his *Chemical and Geological Essays* published in 1874 (and a second edition in 1879). In the latter he shews himself to be an impartial judge, for he remarks, "Having been desired in 1872 to prepare for publication a notice of the scientific labours of Murchison, it became necessary for me to examine critically the whole ground of the Cambrian and Silurian controversy, a task which proved much more serious than I had supposed, and brought to light facts which both surprised and pained me." The result of Murchison's mistake was that he had no base-line to his system, and his subsequent tactics are thus summed up by the present occupant of the Woodwardian Chair in the discussion of a paper by Dr Hicks (*Q. J. G. S.* May, 1875), "The Silurian system had not, and after several changes has not for its upper boundary, a line representing any break in the continuity of deposition. Nor

had it at first, nor has it now, after much modification, any well-defined natural boundary for its base-line. The only break in it is that which occurs at the base of the May Hill Sandstone; and that was unrecognised till pointed out by Prof. Sedgwick many years after the publication of the 'Silurian System,' the author of which, seeing that his system had no base on which to rest, took in group after group of the underlying series, and to justify himself had to prove at each step that as yet no break had been found in the series; till at length he got down to the lowest Cambrian, part of which he included in his Primordial Silurian. It was now well known, and that chiefly through the labours of Mr Hicks, that no strong line could be drawn there, and we must therefore take it down to the bottom of the Cambrian conglomerate, or up to the base of the May-Hill Sandstone. Between these horizons lie the Cambrian rocks of Prof. Sedgwick, a well-defined natural group and an ancient name, which, following the true principles of classification and justice in our nomenclature, we must adopt." Let us now apply our principles to this Cambrian system of Prof. Sedgwick, so maintained by Prof. Hughes, and see whether or not it will stand the test. In the first place we may apply the physical tests.

Elevation and denudation occurred in the typical area after the deposition of the Precambrian rocks, as amply proved by the recent labours of Dr Hicks, Profs. Hughes and Bonney, and others. We have therefore a base-line to the Cambrian rocks in this area, and this base was detected by the keen-eyed Sedgwick long before it was suspected by others, for he speaks of certain crystalline rocks of Anglesea as belonging to "a distinct epoch from the other rocks of the district, and evidently older." Similarly in other areas we find the Cambrian conglomerates resting unconformably upon Precambrian rocks, as in Scandinavia and Bohemia, although these Cambrian conglomerates are not all of the same age, as we should naturally expect of beds formed against gradually subsiding continental areas. In Wales for instance the conglomerates in some cases are of the age of the Harlech beds, in others perhaps of the Menevian Lingula Flag or Tremadoc beds, as shewn by Prof. Hughes to

be the case in Anglesea; in parts of Carnarvonshire of the Tremadoc or Arenig as at Twthill. In the latter case the overlap of the Arenig beds is not upon other Cambrian beds, as maintained by Professor Ramsay in the 'Geology of North Wales,' but actually upon Precambrian rocks.

Elevation and denudation again took place in the type area after the deposition of the Cambrian rocks and before the deposition of the oldest Silurian rocks, which rest unconformably upon the former, and contain fragments of them in their basement conglomerates, and have a strike differing from that of the Cambrian rocks. This break, like that at the base of the System, is not confined to the type-area only, but occurs in other areas remote from it. It has been stated by Prof. Lapworth (G. M. Dec. II. vol. VI. Jan. 1879), that the upholder of the classification of Prof. Sedgwick "seeks in all kinds of out-of-the-way spots for evidences of local unconformities between the *Balas* and the *Llandoveryies* to satisfy his stratigraphical conscience that there is sometimes an actual physical break between them; when, without leaving his closet, he could assure himself of the fact that the two systems of the so-called Lower and Upper Silurian are already known to be stratigraphically concordant nearly all over the world." This may be so, but the supporter of the Sedgwickian classification has had sufficient experience of books to assure himself that it is much safer to trust to field-work than to depend upon book-reading for such facts as those under consideration. On examining the junction between these 'Balas and Llandoveryies' in various parts of Europe I have seen evidence of a physical discord not only in the typical area, but also in the North of England, Scandinavia, and Bohemia, and strangely enough one may find this borne out, even without leaving one's closet, by the evidence furnished by other writers: for instance, in the North of England, Mr Aveline states that the Stockdale shales (the equivalents of the 'Llandoveryies') rest unconformably upon the Coniston Limestone, belonging to the Bala series (G. M. vol. IX. p. 441 and Dec. II. vol. III. p. 282). Again, M. Barrande (Def. des Col. iv. p. 109), states that the beds of E. e. 1. (also equivalents of the 'Llandoveryies') rest uncon-

formably upon the representatives of the Bala (D. d. 5). In many parts of North America again there is a stratigraphical break recorded by Dr Sterry Hunt (*Chem. and Geol. Essays*, p. 416), between the Oneida group and the Hudson River group, and in the table on p. 386, the Oneida group is placed in the Silurian System of Sir R. I. Murchison, and the Hudson River Group in the Cambrian of Prof. Sedgwick.

We may therefore assert that the physical evidence derived from the occurrence of unconformities produced by the action of elevation and denudation after the deposition of the Bala rocks and before the deposition of the May Hill rocks, tends to shew that the latter should be included in a system different from that containing the former: the same conclusion is borne out by the occurrence of conglomerates at the base of the equivalents of the May Hill rocks, such as are found in Britain, Bohemia, Scandinavia, and North America. Such conglomerates accompanying wide-spread unconformities are of considerable classificatory value, even if they be not so thick as the "persistent conglomerates that...occur in the very heart of his (the Sedgwickian's) own Cambrian system" upon which Prof. Lapworth lays stress. The evidence derived from change of lithological character and the occurrence of a more strongly marked cleavage in one system than in another is valuable, although such signs are usually more local than the physical break above referred to, but in limited areas it is of considerable importance in separating off the two groups. I have before referred to the occurrence of a double cleavage in many of the Cambrian rocks of the Lake District, whereas in the Silurian rocks only a single cleavage is found. In the same district the frequent lamination of the Silurian rocks and its comparative rarity in the Cambrian is noteworthy. In many areas, as the Welsh borders, Bohemia, and parts of Scandinavia, the occurrence of thick masses of limestone in the Silurian rocks is a contrast to their scarcity and feeble development in the Cambrian system. Again, there is often a discordance of strike in the two systems, as Professor Sedgwick observed (*Introd. Brit. Pal. Rocks and Foss.* p. xxvii), "the Cambrian series is now physically and palæontologically well separated

from the Silurian by the intervention of the May Hill Sandstone. Commencing with the May Hill group, there is a sudden change of mineral type, and an obvious physical break, sometimes marked by a change of strike, and clear discordancy of position.....So far as regards the evidence supplied by Wales and the bordering English counties, and by the north of England, the question respecting this line of demarcation is, I think, perfectly set at rest; nor does there appear to be anything in the development of the older Palæozoic series of the continents of Europe or America which is opposed to this conclusion."

The palæontological evidence is equally satisfactory. In the Introduction to the "British Palæozoic Rocks and Fossils" Professor Sedgwick states that, "taking Sir R. I. Murchison's list, as published in the Appendix to his 'Siluria,' and without any deduction whatsoever, it does not give us much more than ten per cent. of species common to true Cambrian and true Silurian British rocks. But when we have struck out from this common list (1) all those species which range beyond the limits of the Lower Palæozoic Division, into the Devonian and Carboniferous groups, (2) all species of doubtful authority, (3) all species of which the geological place is not established on good physical evidence, (4) all species which however abundant in the *lower series*, disappear in the *upper* either altogether, or ascend into it through so very limited a space above the line of demarcation as to produce no general impress on the upper Fauna:—when all this has been done, I have no doubt that the number of *common species* will fall *considerably below ten per cent.*: perhaps as low as the percentage shewn by the Palæozoic series of North America or Bohemia; but not as low as the percentage shewn by the Cambrian and Silurian rocks of the North of England."

We see then that a good break between the May Hill Sandstone and the Bala rocks, in other words, between the Cambrian system of Sedgwick and the Silurian may be established both by physical and palæontological evidence. I have also already pointed out that a good physical break occurs at the base of the strata included by Sedgwick in

his Cambrian system, although we cannot at present establish a palæontological break there, owing to the rarity or absence of organisms in the rocks older than that system. The Cambrian System of Sedgwick therefore is well established according to the principles of classification already advocated. It now remains to be seen whether other classifications of the Cambrian and Silurian rocks can be similarly maintained.

The following table of the principal classifications subsequently proposed for those rocks which were originally defined by Sedgwick and Murchison as Cambrian and Silurian has previously been given in the *Geological Magazine*. (G. M. Dec. II. vol. VIII. p. 248).

Murchison ignores the great break in the middle of his Silurian system, and draws the base of his system at a horizon where there is no break, stratigraphical or palæontological, for there is a complete conformity between the Menevian and Harlech series. The same objections apply to the classification proposed by Professor Jukes.

Lyell and Hicks draw their line between the Cambrian and Silurian at a horizon where there is no break, as shewn by M. Barrande in his paper on the Maintenance of the Silurian Classification of Murchison. As with Murchison and Jukes also, they leave the great break in the middle of their Silurian system.

Phillips also draws the line between the Cambrian and Silurian at a horizon where there is no break, and like the others leaves the great break in the middle of the Silurian System.

The same objection may be raised to the classification of the Geological Survey.

Professor Lapworth separates off the Silurian from the Ordovician at the horizon where a great break is established, but draws another line between Ordovician and Cambrian at a position where there is no break.

Finally, Professor Ramsay ignores the break in the middle of his Silurian system.

Having seen that the nomenclature of Professor Sedgwick will alone stand the tests applied, we may proceed to examine briefly the objections raised to this nomenclature. Besides the

	Sedgwick.	Murchison. 1868.	Jukes, 1863.	Lyell, 1871. Hicks.	Phillips, 1853.	Geological Survey, 1866.	Lapworth, 1879.	Ramsay, 1878.
Ludlow	Silurian	Upper Silurian	Upper Silurian	Upper Silurian	Upper Silurian	Upper Silurian	Silurian	Silurian
Wenlock								
Upper May Hill								
Lower May Hill								
Bala { Upper Middle Lower (or Llandeilo)		Lower Silurian	Lower Silurian of Cambro- Silurian	Lower Silurian	Lower Silurian	Lower Silurian	Ordovician	
Arenig								
Tremadoc								
Lingula Flags								
Menevian		Primordial Silurian			Cambrian		Cambrian	
Harlech								

trivial objection that the nomenclature of Murchison has been so long in use (a statement hardly borne out by the preceding table) that it is too late now to adopt any other, other objections have also been brought forward. Professor Lapworth remarks as follows: "The Silurian is cut down (by the Sedgwickian) so as to include the Upper Division only of Murchison's original System; while all the fossiliferous beds below are assigned to the Cambrian. That in this way he commits precisely the same scientific error as the Murchisonian never seems to occur to his imagination. That every fact adduced in support of Sedgwick's claim to the rocks of the *Second Fauna* can be met by one in Murchison's favour equally cogent is forgotten. That every error committed by the latter to the destruction of his claims can be paralleled by one equally fatal to those of his opponent is similarly ignored. He has long since convinced himself of the fact, that the Silurian, as he restricts it, is quite large enough to form a system by itself, and that its fauna is grand enough and special enough to characterise one; but we never find him carry out this argument to its legitimate conclusion—that, if so, his own Cambrian is not *one*, but *two* systems, whose individuality he is, by his own principles, equally compelled to recognise." In other words, Professor Lapworth objects to the Sedgwickian on the ground that he will not admit a break as occurring in the centre of his own Cambrian group. But where is this break to be drawn? Professor Lapworth himself draws it at the base of the Arenig series; now in the list of the Tremadoc fossils given in the Cambridge Catalogue, we find that of eleven genera, two are *peculiar* to the Tremadoc beds, one occurs both *above* and *below*, two occur *below* only, and six *above* only, i.e., nearly 60 per cent. of the genera range into the Arenig rocks, and not 20 per cent. into the Ffestiniog or Lingula Flag series; also, in a complete list of Tremadoc species published by Mr Robert Etheridge (Mem. Geol. Survey, vol. III. p. 354), out of 85 species recorded, fifteen pass up into the Arenig rocks, whilst only eight pass down into the Lingula Flags, consequently if a break is to be drawn at all on palæontological grounds, it should be drawn at the base of the Tremadoc and not of the Arenig series.

Professor Ramsay draws a physical break at the base of the Arenig series, partly on account of the occurrence of a grit band at that horizon, and partly because he considers that in Carnarvonshire the *Lingula* Flags and Tremadoc Slates thin out, and the Arenig rocks rest upon the representatives of the Harlech series: I have already pointed out that in reality the beds upon which the Arenig rocks rest are not the equivalents of the Harlech but are really Precambrian. There is no break therefore at the base of the Arenig, either physical or palæontological. M. Barrande (*Du Maintien de la nomenclature établie par M. Murchison*) draws the line at the base of the Tremadoc but admits that there is a mixture of forms of his second and third faunas in the Tremadoc beds themselves, and this seems everywhere to be the case, *e.g.* in our own Tremadoc rocks, which contain *Conocoryphe* and *Olenus* along with *Cheirurus*, *Niobe*, and *Psilocephalus* or *Illænus*, in the band d 1 β of Bohemia, which has *Harpides* (*Erinnys*) with *Amphion*, in the *Ceratopyge* limestone of Scandinavia, and in the *Levis* and *Chazy* series of America, which Dr Sterry Hunt on page 386 of his *Chemical and Geological Essays* correlates with the Tremadoc, and which he says (p. 415) "offer a commingling of forms of the first and second faunas, which shews them to belong to a period of transition between the two." The small palæontological gaps which occur between these lower series (primordial of Barrande), seem to be due to lack of deposition, and of suitable conditions for the existence of life, rather than to any important physical movements (except perhaps of depression), and in other areas where such pauses have not occurred, in Sweden, for instance, where the beds yield a continuous sequence from the bottom of the representatives of the Harlech to the top of the representatives of the Bala series, these palæontological gaps cannot be observed, because during pauses of deposition of mechanical sediment animals still lived on the sea-floor and accumulated deposits of limestone, so bridging over periods which are perhaps represented in Britain by slight gaps. There is yet another circumstance which tends to make these gaps appear greater in Britain than they really are, namely, that our opportunities of collecting fossils in Britain are rarer than those of foreign

geologists, consequently we shew a preference for working out the richer zones and do not give so much time as would be desirable to the more barren intermediate beds.

Professor Lapworth does not pay so much attention to the line of demarcation between his Cambrian and Ordovician (Ordovician) systems as to the occurrence of what he considers to be three distinct faunas. He says, "Amid all the confusion incident to this controversy, one grand fact stands out clear and patent to the most superficial student of Palæozoic geology, viz.—the strata included between the horizon marking the advent of *Paradoxides*, and the provisional line presently drawn at the summit of the Ludlow, imbed *three distinct faunas*, as broadly marked in their characteristic features as any of those typical of the accepted systems of a later age...The keen-eyed and philosophic Barrande was the first to recognise this truth, and his addition of the 'Primordial' to the First and Second Faunas of Murchison's original Silurian marked a geologic era equal in importance to the establishment of a new system." It seems to me however that the three faunas are by no means so nicely marked as Professor Lapworth assumes, the only Primordial beds, with a few exceptions, which have been examined in detail being deep-water deposits, and having faunas largely composed of the variable group of trilobites. By using these creatures as a basis of classification several faunas might be built up out of the Cambrian and Silurian rocks: what can be more marked, for instance, than the great abundance of *Paradoxides* in the Menevian beds, its absence in the *Lingula* Flags, and the abundance of *Olenus* in those beds? The selection of the genus *Paradoxides* as an example is indeed singularly unfortunate. The Cambrian system, as defined by Professor Lapworth, is about 12,000 feet in thickness at St. David's, and the genus *Paradoxides* is limited to a band about 1500 feet thick in the centre of this. The genus *Olenus* on the other hand ranges through about 6000 feet of rock: why not have a fourth fauna?

M. Barrande also, as stated, from palæontological considerations, separates his so-called Silurian system (which really includes the Cambrian system as well as some Precambrian

beds!) into groups characterised by three faunas, but the characteristics of these faunas given by him in a recent paper (Du Maintien &c.) admit of so many exceptions as to be of very doubtful classificatory value. He states that his Primordial fauna is composed almost entirely of trilobites, whereas we know that wherever shallow-water deposits occur brachiopods abound. Again the trilobites of the Primordial fauna are said to be distinguished by their conformation, the head being small, the thorax large, and the tail composed of few segments, but I have pointed out (G. M. June 1881) that many trilobites of the second fauna, as *Remopleurides*, *Acidaspis*, and various genera of the *Cheimuridæ*, are strictly comparable with *Paradoxides* &c. of the Primordial fauna. The Second fauna is described as possessing trilobites which contrast with those of the Primordial group; either the head, thorax and tail are pretty nearly in equilibrium, as in *Asaphus*, or the thorax is reduced, and the head and tail developed, as in *Illaenus*. On examination however we find that these trilobites do not really contrast with those of the Primordial group, and moreover that this conformation is rather the exception than the rule among the trilobites of the Second fauna. Now M. Barrande attempts to shew that although these three faunas are distinct, there nevertheless exist beds of passage connecting them indissolubly into one system, and he proves his point in one case, namely that beds of passage occur between the beds containing the Primordial and those containing the Second fauna (the Tremadoc series as before shewn), but I think he breaks down in attempting to shew that beds of passage exist between his Second and Third faunas. He states that in the Llandovery group of England, which has been well studied, the inferior portion contains principally species of the Second fauna, whilst the superior holds a majority of species of the Third fauna. Our geologists now however for the most part group the Llandovery or May Hill group entirely with the beds containing the upper fauna, whilst so far is our knowledge of these rocks from being complete, that there is still a great deal of confusion about certain beds, as to whether they are of Upper Bala age, or belong to the lower part of the May Hill beds. This confusion may be well seen by comparing with one

another the various lists of fossils in the third volume of the Geological Survey Memoirs, but to this reference will be made in a future chapter. On forming a true list of unequivocal British May Hill fossils it will be found that, as is also the case with their representatives abroad, the May Hill beds undoubtedly belong palæontologically as physically to the Silurian system, and do not form beds of passage. M. Barrande appeals to his 'colonies,' as affording an admixture of organisms of his Second and Third faunas. These colonies are in our opinion to be explained as due to physical disturbances (*Q. J. G. S.* xxxvi. p. 591), but I may point out that the theory of colonies was in great part founded owing to a mistake of English geologists. Murchison not only made a mistake concerning the position of the Llandeilo rocks, but another with regard to their fossils: having found that graptolites occurred largely in his true Llandeilo beds, he went further and considered nearly all black shales in which graptolites were found to be Llandeilo. In this way numerous graptolites which we now know by the labours of Prof. Lapworth to belong exclusively to the Silurian rocks (those of the Birkhill group) were quoted as occurring in Llandeilo, and it was to these graptolites that M. Barrande appealed, as affording evidence of a fauna in the north-west of Europe prior to its advent in Bohemia. Although the graptolitic beds have as remarked above been assigned to their true position, yet organisms higher than graptolites which occur in them, are still frequently quoted as occurring in Llandeilo beds. To give one example, *Peltocaris aptychoides* is recorded in Woodward's Catalogue of British Fossil Crustacea as being found in Llandeilo rocks, whereas the beds in which it is found belong to the Birkhill series. In this way probably many true Silurian forms have crept into Cambrian lists. It is possible that in this way *Cardiola interrupta* is still retained in lists of Llandeilo fossils.

The objections raised to the classification of Professor Sedgwick, and the evidence brought forward in favour of other classifications having been now examined, we may draw our own conclusions as to their bearing. Surely all the evidence points to the adoption in its entirety of the nomenclature of the late Woodwardian Professor!

§ III. *Description of the Series of the Cambrian and Silurian Rocks of the British Isles.*

The various series of the British Isles may be very briefly described, taking them in order according to their geographical distribution, and in order that those of different areas may be compared with one another, short accounts of their lithological characters, and of the principal fossils which they contain will also be given.

I have already remarked on the value of the Rhabdophora, as enabling us to correlate beds widely separated horizontally. No one who has carefully read the researches of Professor Lapworth can fail to be convinced of this fact. The remarkable occurrence of the graptolites in Sweden, where they have been described by Dr. S. A. Tullberg as occurring in bands, zone for zone comparable with those of Southern Scotland, is alone sufficient to indicate their value. In his volume on Lamellibranchs (*Ext. du Syst. Sil. du Centre de la Bohême*) at p. 77, M. Barrande considers that *Cardiola interrupta* does not allow us to establish any restricted contemporaneity between two horizons in countries geographically separated, where its presence has been determined, and he goes on to remark that this fact shews us how imprudent it would be to establish by any fossils, graptolites or others, absolute contemporaneity of a numerous series of equivalent zones in the Silurian basins of Europe and America.

But assuming that the statements are correct from which M. Barrande draws his conclusions as to the distribution of *Cardiola interrupta*, it does not follow that because *Cardiola interrupta* does not occur on the same horizon in different countries, that therefore graptolites do not, because *Cardiola interrupta* is frequently found in sandstones and limestones, deposited in shallow water, whereas graptolites often occur in deep-water deposits, and I have already said enough in Chapter I to shew that the mode of occurrence of shallow-water and deep-water forms is very different in the older rocks just as it is at the present time, and I also pointed out the anomalous mode of

distribution of many of the graptolites. In fact the more we learn about the geographical distribution of the Rhabdophora, the more inclined must we be to believe with the great exponent of this group of organisms that "the Graptolites are destined to play among the Lower Palæozoics the part filled by the Ammonites among the Jurassic rocks, in fixing the minor divisions of the deep-water beds, and in determining their parallelism in areas now geographically separated." Along with these graptolites occurring in deep-water beds are often found trilobites, and we find that in this case also the organisms are very valuable in comparing deposits widely separated, whereas those trilobites occurring in shallow-water deposits usually have a very different range. Of other fossils, the molluscs and the phyllopod crustacea are perhaps most useful, the corals in many cases having too long a distribution in time, whilst other organisms are too local. In a word, it is by comparing the different deep-water deposits that we are most likely to institute successful comparisons of the order of succession of beds in areas widely separated, for we find in these cases that lithological and palæontological characters are very constant over wide areas, whereas the intermediate shallow-water beds often differ much from one another, as we should naturally expect, and are only to be correlated by observing their relative positions with regard to deep-water deposits.

The Cambrian system was separated into subdivisions which we have now agreed to term series by Prof. Sedgwick, and with one or two modifications his subdivisions are generally accepted at the present day. Sir Roderick Murchison also divided his Silurian rocks into series, some of which are now usually accepted, but as Prof. Lapworth has recently pointed out, Murchison drew up some of his divisions rather from æsthetic considerations than with strict regard for the physical and palæontological evidence. The following is a list of the series of the Cambrian beds of Britain, which will be adopted in the ensuing pages, commencing with the basement beds:—

Harlech

Menevian

Lingula Flag (or Ffestiniog)

CLASSIFICATION OF THE

Tremadoc
Arenig
Llanvirn
Bala { Lower Bala (or Llandeilo)
Middle Bala
Upper Bala

The Silurian system contains the following series, also commencing with the lowest :—

May Hill (Valentian)
Salopian (Wenlock and Lower Ludlow)
Downtonian.

CAMBRIAN SYSTEM.

1. *North Wales.*

Harlech Series. Beds of this series are found in Merionethshire, and in Carnarvonshire in the neighbourhood of Bangor, Llanberis, and Nantlle. Those of Merionethshire are "comprised in a broad mountain tract, forming an irregular oval, of which the widest diameter from north to south is about 15 miles, and that from east to west about 10 miles.

The rocks of this region principally consist of coarse quartzose, greenish grey grits.....The beds seemed to have been formed partly by the direct waste of rocks of a granitic character, or at least into the composition of which quartz and felspar largely contributed. Occasionally the strata are conglomeratic, quartz, and more rarely felsitic pebbles, being disseminated in a gritty base.....Sometimes they are purple and fine grained, and they are intermingled with occasional bands of greyish green and purple slates, which, especially towards the lower part of the series, attain a considerable development. Excepting Annelide tracks and borings, no fossils have yet been observed; " (Ramsay, *Geology of North Wales*, p. 19). Sir A. Ramsay gives the greatest thickness at 6000 to 7000 feet. Between the Harlech beds of Carnarvonshire and Merionethshire lies a great synclinal fold, the highest beds of which are found on the summit of Snowdon. "The best sections are in the Passes of Llanberis and

Nant Francon, where the succession of the strata, as a whole, is as follows:—The highest beds consist of about 1,300 feet of green, greenish grey, and occasionally of purple hard grits, generally thick-bedded, and formed of grains of quartz often but little waterworn, intermingled with felspar grains in smaller proportion....Beneath the grits rise the bluish purple and purple slates of the larger slate quarries of Penrhyn and Llanberis, and below these are other thinner bands of slate, grit, and conglomerate." (Ramsay). This conglomerate is largely composed of felsite pebbles in a felsitic matrix, and rests unconformably upon felsite flows of Precambrian age. A somewhat similar succession is seen at Moel Tryfan, where the basement conglomerate rests upon Precambrian beds of an ashy character. It is succeeded by red slates, worked in the Alexandria quarry; these are overlain by grits, and a higher band of purple and green slates is worked in the quarries of Nantlle. At Bangor also the basement conglomerates of the Harlech series rest unconformably upon Precambrian rocks, and are succeeded by grits and slates.

Menevian Series. These beds are found in Merionethshire, and rest conformably upon the underlying beds, also passing conformably into the overlying series.

The junction with the Harlech beds is described by Sir Andrew Ramsay as being well seen about half a mile E. of Barmouth, where the Menevian beds consist of dark blue slates. Other localities are Tyddyngwladis and Tafarn Helig. Thickness 100—200 feet.

List of Characteristic Fossils.

Protospongia fenestrata	Holocephalina primordialis
Agnostus princeps	Anopolenus Henrici
A. reticulatus	Paradoxides Davidis
Microdiscus punctatus	Erinnys venulosa

Lingula Flag or Ffestiniog Series. The beds of this series occur in many places in Merionethshire and Carnarvonshire, especially around Dolgelly and Ffestiniog in the former county, and near Portmadoc and Bangor in the latter. They consist towards the summit of black slaty shales often iron-stained, from

200 to 1000 feet in thickness as recorded by Prof. Sedgwick, and below these are hard, laminated, flinty sandstones, 2000 feet thick. The following divisions of this series are given in a table (Ramsay, *Geology of North Wales*, p. 343) by Mr. Salter.

Lower Lingula Flags	1. A lower series of black pyritous slates, with many beds of intercalated sandstone near the base. Mæntwrog Waterfall, &c. &c. Fossils: <i>Agnostus princeps</i> , <i>Olenus cataractes</i> , <i>Lingulella Davisii</i> .
	2. A middle thick sandy series, the typical "Lingula flag" of Tremadoc, Ffestiniog, Dolgelly, &c. Carnedd-y-Filiast, Bangor. Fossils. <i>Olenus micrurus</i> , <i>Hymenocaris vermicacla</i> , <i>Lingulella Davisii</i> in great abundance, <i>Cruziana semiplicata</i> .
Upper Lingula Flags	3. An upper black slate, with hard pyritous bands, especially at the base, thickly crowded with fossils. Tremadoc, Mæntwrog, and W. of Ffestiniog. Fossils, <i>Olenus alatus</i> , <i>O. scarabæoides</i> , <i>Agnostus princeps</i> , several sp. of <i>Conocoryphe</i> , <i>Orthis lenticularis</i> , <i>Dictyonema ? sociale</i> ."

To these fossils the following may be added:—

- Parabolina* (O.) *spinulosa*, U.
- Ctenopyge* (*Olenus*) *flagellifera*, U.
- S.* (O.) *humilis* U. (= *O. alatus*).
- Conocoryphe ?* (*Acerocare*) *ecorne ?*
- Dikellocephalus celticus*, U.
- Lingulella lepis* L. and U.
- Kutorgina cingulata*, U.

Tremadoc Series.

"Lower, chiefly Black Slate.

Upper. Sandstones, grey and bluish:iron beds: ferruginous slate, &c.)" (Salter. *Cat. Camb. and Sil. Foss.* p. 15.)

The characters of the formation may...be examined in the sea-cliffs of Ogof-ddu near Criccieth, where the harder grey Lower Tremadoc slate, with many lines of ashy material, is seen to overlie and pass down into the upper black slate, full of fossils. But here the Tremadoc series is barren of fossils, and

we must refer to the opposite side of the anticlinal axis, and examine the sections near Moel-y-gest, and other places in the Tremadoc district, in order to find the fossiliferous zones" (*Geol. North Wales*, p. 356).

The Tremadoc slates are seen in the Promontory of Penrhyn between Traeth-bach and Traeth-mawr, Portmadoc, and the following section is given in ascending order:—

"2. 3. 4. Iron-stained dark slates, with a thick series *above* them of hard blue rock, sometimes almost massive, with occasional beds of pisolitic iron, and with many lines of felspathic matter. (A few beds of the same nature lie below the dark slates.) *Psilcephalus innotatus*, *Niobe Homfrayi*, with small *Lingulellæ*, and *Dictyonema sociale* are characteristic of it.

[Lower Tremadoc slate.] Hills above Aber-ia, near Deudraeth.

5. 6. Slate with a pencil fracture, in thick beds, interspersed with hard, tough, and sandy layers, the same as those quarried for building at Portmadoc. *Asaphus Homfrayi* was found here. The same beds rich in fossils at Tremadoc.

7. 8. Alternating series of hard bluish flat-bedded slates and pencil slate...; fossils rare. Penamser east of Tremadoc, Penrhyllwyd, &c. [The iron-ore occurs in this series at Tremadoc.]

9. Soft thin bedded sandy shales. Marsh opposite Deudraeth, Minffordd, &c.

10. Hard bluish flags. Garth Hill, north side of west end of hill, and south side of east end, reaching to Deudraeth. Rich in fossils...*Angelina Sedgwickii*, *Asaphus Homfrayi*, *Cheirurus*, *Ogygia scutatrix*, *Conularia*, *Orthoceras*, &c., with large specimens of *Lingulella Davisii*" (*Geol. North Wales*, p. 86).

The thickness of these rocks is about 1000 feet.

Beds of pisolitic ironstone occur at Bettws-garmon and have been correlated with the Tremadoc beds. Sir A. Ramsay considers that these beds thin out towards the Menai Straits (*Geol. North Wales*, p. 250) and this can be well explained, for at Carnarvon we find Arenig ? (or Llanvirn) rocks resting against the old Precambrian ridge which is found there, and which must have stood up as a ridge of land in earliest Cambrian times, and undergone gradual submergence. On the north-west side

of this ridge Professor Hughes has detected Tremadoc rocks of shallow-water character in Anglesea (*Q. J. G. S.* vol. xxxvi. p. 237). Quartz-jasper conglomerates are described by him as passing into grey sandstones which weather yellow and contain *Orthis carausii* and *Neseuretus ramseyensis*. The following is a list of fossils characterising these rocks in North Wales:—

Niobe Homfrayi	<i>Ceratiocaris</i> ? <i>latus</i>
<i>Psilocephalus innotatus</i>	<i>C</i> ? <i>insperatus</i>
<i>P. inflatus</i>	<i>Lingulella lepis</i>
<i>Conocoryphe depressa</i>	<i>Orthis carausii</i>
<i>C. verisimilis</i>	<i>Theca operculata</i>
<i>Angelina Sedgwickii</i>	<i>T. bijugosa</i>
<i>Dikellocephalus furca</i>	<i>T. arata</i>
<i>Asaphus affinis</i>	<i>T. trilineata</i>
<i>A. Homfrayi</i>	<i>Conularia Homfrayi</i>
<i>Ogygia scutatrix</i>	<i>Bellerophon arfonensis</i>
<i>Neseuretus ramseyensis</i>	<i>B. multistriatus</i>
<i>Cheirurus Frederici</i>	<i>Orthoceras sericeum</i>
<i>Lingulocaris lingulæcomes</i>	

The admixture of so-called 'primordial' forms with later ones will be noticed.

Arenig Series. A considerable amount of confusion prevails concerning the beds which should be assigned to this series in North Wales. The following classification of these rocks is given by Dr Hicks (*Q. J. G. S.* xxxii. p. 137).

Upper Arenig.	{ "a. Shales of Bangor and Carnarvon, and shales under and mixed up with the lower ash-beds in the Arenig mountains, and to the N.E. and N.W. of Portmadoc.
	{ b. Slates at Ty Obrey, and under the above near Arenig.
Middle Arenig.	{ Grit bed at Ty Obrey, &c.
Lower Arenig.	{ Upper Tremadoc rocks near Portmadoc, and black slates under the grit bed near Arenig, &c."

The upper Arenig of the above must now be grouped with the Llanvirn series, according to Hicks, so that the grit bed at

Ty Obrey, &c. (Garth Grit), instead of forming the base of the Arenig, really forms its upper member, unless indeed the beds of Ty Obrey and Tai-hirion be included with the Arenig series as seems to be indicated by their fossils.

The following fossils are given in the *Geology of North Wales*, p. 376.

At Manod Ffestiniog. *Calymene parvifrons*.

At Tai-hirion. *Agnostus* sp. *Calymene parvifrons*, *Ogygia Selwynii*, *Diplograptus pristis* (this can hardly be Hisinger's species), *Theca vaginula*, *Obolella* like *plumbea*, *Orthis testudinaria*.

At Ty Obrey. *Calymene parvifrons*, *Æglina caliginosa*, *Dionide atra*, *Diplograptus mucronatus*, *Climacograptus teretiusculus*, *C. bicornis*, *Dicellograptus ramosus*, *Dendrograptus furcatula*, *Lingulella lepis*, *Ctenodonta*, *Palæarca socialis*, *Conularia corium*, *C. margaritifera*, *Theca vaginula*, *Orthoceras*, *Dictyonema sociale*?

The following then seems to be the succession of the Arenig beds of North Wales:

1. Hard grey or bluish flags, with *Asaphus Homfrayi*, *Angelina Sedgwickii*, *Ogygia scutatrix*, *Lingulocaris lingulæcomes*, *Cheirurus Frederici*, *Conularia corium*, *Lingulella Davisii*, *Callograptus*, &c.

2. Garth Grit.

3. Shales of Ty Obrey, Tai-hirion, &c.

Owing to this recent change of nomenclatures it is impossible to give a thickness of the Arenig rocks of North Wales. At Cader Idris; the Moelwyns, the Aran and Arenig mountains, volcanic lavas, ashes, and agglomerates occur with thicknesses varying from 1000 to 5000 feet.

The grit beds and conglomerate which have been described by Prof. Hughes as occurring above the Precambrian rocks of Twthill, Carnarvon, may belong to this series, but it is doubtful whether true Arenig beds have been described in Anglesea, the recorded fossils pointing rather to the Llanvirn age of the beds which contain them.

Llanvirn Series. Dr Hicks in the *Popular Science Review* (N. S. vol. v.), correlates certain beds near Carnarvon with this

series, on account of the affinities of a group of fossils found by myself in 1875, with those of his true Llanvirn beds. The beds consist of bluish black, micaceous shales, with little or no cleavage, the particles of the rock being exceedingly minute. Their thickness has not been measured.

The following fossils occur :

Didymograptus bifidus	Trinucleus sp.
D. indentus	Barrandea sp.
D. Murchisoni	Obolella sp.
Caryocaris Marrii	Bellerophon perturbatus
Æglina Hughesii	Orthoceras Avelinii.

In Anglesea, Professor Hughes has found black shales, resting upon brown sandstones near Llangwyllog church, containing :—

Dicellograptus n. sp. allied to D. sextans
 Diplograptus dentatus
 D. foliaceus
 Climacograptus confertus
 C. coelatus
 Glossograptus ciliatus

and the Geological survey lists also give :—

Æglina major
 Trinucleus Murchisoni
 Illænus Hughesii.

“From the evidence before him, Mr Lapworth is inclined to refer the bed to the middle part of the ‘black-shale group,’ expressing some doubt as to whether they should be called Highest Arenig or Lowest Llandeilo.”

The shales “mixed up with the lower ash beds in the Arenig mountains, and to the N.E. and N.W. of Portmadoc” being correlated by Dr Hicks, as before stated, with the beds of Pont Sciont, Carnarvon, must be also referred to this series.

Lower Bala (Llandeilo) Series. Black Shales found at Tiddyn Diccwm near Tremadoc, were found to contain graptolites by Mr Salter. The following species are recorded by Prof. Lapworth (*Distribution of the Rhabdophora*, p. 27) :

Didymograptus sp.	Diplograptus dentatus
Glossograptus Hincksi	D. tricornis

D. angustifolius	C. bicornis
D. Whitfieldi	Dicellograptus sextans (?)
Climacograptus Scharenbergi	Dicranograptus ramosus.

"There can be little doubt that they are actually of Llandeilo age."

The graptolitic black mudstones of Llanfaelrhys, Anglesea, noticed by Salter are placed by Prof. Lapworth on a higher horizon than the last beds.

He records :—

Dicranograptus formosus
Climacograptus Scharenbergi
Species of Didymograptus.

The only other fossiliferous beds of undoubted Lower Bala age occur in the neighbourhood of Llanrhaeadr-yn-mochnant, especially at Gorwyllt and Craig-y-glyn, where limestone many hundred feet thick rests upon ash-beds. The following fossils are recorded, on p. 388 of the *Geology of North Wales*, from the limestone of Craig-y-glyn :—

Asaphus tyrannus	Orthis vespertilio
Trinucleus concentricus	O. turgida.
Calymene Blumenbachii var.	

Cardiola interrupta is not recorded here or in any other of the localities given in this table.

Middle Bala Series. The beds of this series, owing to the occurrence in places of volcanic rocks of contemporaneous origin, differ immensely both in lithological character and in thickness, but owing to the abundance of fossils usually found in them beds of very different character may easily be correlated.

The only graptolite-bearing deposits of this age in North Wales, recorded in Prof. Lapworth's paper on the *Distribution of the Rhabdophora*, are those in the railway cutting west of Conway. They contain :—

Dicranograptus Clingani	Diplograptus foliaceus
Idiograptus margaritatus	Climacograptus bicornis.

The strata of Lleyn are richly fossiliferous, and vary much in lithological character as seen by the description in the *Survey Memoir*, e.g. Ynysgaled, "brownish yellow sandy beds"; Plas-hen, "black rotten slate"; Pwllheli, "slaty sandy fine-grained

rock"; Crugau, near Llanbedrog, "blue slate with calcareous nodules"; Boduan, "coarse felspathic breccia passing rapidly into brown gritty sandstone."

A list of some of the more important and characteristic fossils is appended; a full list will be found in the *Survey Memoir*, p. 217:

Calymene brevicapitata	Lichas laxatus
Trinucleus concentricus	Orthis spiriferoides
Asaphus Powisii	O. flabellulum
Illænus Bowmanni	Strophomena grandis
Phacops conicophthalma	Lingula ovata
P. apiculatus	Bellerophon bilobatus
Homalonotus bisulcatus	Pterotheca corrugata.
Cybele rugosa	

The calcareous ashy beds (correlated by Ramsay with the Bala limestone), which cap the summit of Snowdon, and some of the neighbouring hills contain well-known Middle Bala fossils.

In Anglesea there are no very fossiliferous beds of undoubted Middle Bala age.

The beds of Denbighshire and Montgomeryshire are in places richly fossiliferous, but present no very divergent lithological characters. Fossil lists will be found in the Appendix of Volume III. of the *Geological Survey Memoirs*.

In Merionethshire, the beds of the typical Bala area merit a somewhat fuller consideration.

The beds below the Bala Limestone consist of black shales, often very fossiliferous, about 4000 feet in thickness. In places they assume a somewhat arenaceous character. The Bala Limestone itself is usually under fifty feet thick, and differs in lithological character, being often interstratified with ashy calcareous shales. At Rhiwlas it is a dark-grey limestone apparently deposited in rather deep water. The beds above the Bala Limestone consist of dark shales, about 3000 feet in thickness, some of which, by their fossils, must be included in the Middle Bala series, the Upper Bala beds being those in immediate association with the Hirnant Limestone.

The following list contains some of the more characteristic fossils:—

<i>Choetetes petropolitana</i>	<i>Ampyx tumidus</i>
<i>Echinosphaerites Balticus</i>	<i>Trinucleus concentricus</i>
<i>E. granatum</i>	<i>T. seticornis</i>
<i>Glyptocrinus basalis</i>	<i>Cythere umbonata</i>
<i>Palæaster obtusus</i>	<i>Beyrichia complicata</i>
<i>Agnostus trinodus</i>	<i>Lingula ovata</i>
<i>Asaphus Powisii</i>	<i>Orthis actoniae</i>
<i>Calymene brevicapitata</i>	<i>O. flabellulum</i>
<i>Cheirurus juvenis</i>	<i>O. calligramma</i>
<i>Cybele rugosa</i>	<i>O. alternata</i>
<i>Homalonotus bisulcatus</i>	<i>O. spiriferoides</i>
<i>Illænus Davisii</i>	<i>O. testudinaria</i>
<i>Lichas laxatus</i>	<i>O. vespertilio</i>
<i>Phacops apiculatus</i>	<i>Strophomena rhomboidalis</i>
<i>Remopleurides Colbii</i>	<i>Cyrtoceras sonax.</i>
<i>R. allied to radians</i>	

For details of sections of the beds near Bala, I would refer to a valuable paper by T. Ruddy, Esq. (*Q. J. G. S.* xxxv. p. 200).

Upper Bala Series. There is considerable doubt at present what beds should be included in this series; some beds having been referred to this, which probably belong to the Middle Bala, and again, there has been considerable confusion between the Upper Bala and the lowest part of the May Hill group; I shall therefore confine myself to a short description of beds which Sedgwick placed in the Upper Bala group, and which contain fossils quite distinct from those of the Middle Bala, some of which are distributed very widely through Europe; these beds are those grouped under the term Hirnant Limestone. This stage consists at the base of a series of fossiliferous shales succeeded by thin bands of limestone, associated with fossiliferous grit. The stage has been well described in the paper by Mr Ruddy, to which reference was made before. A good section of this stage is described by him (p. 205), and the following is the succession:—

2. Highly fossiliferous shales, full of Hirnant species 20 feet. *Orthis hirnantensis*, *O. sagittifera*, *O. biforata*, *O. elegantula*, *Nebulipora lens*, *Favosites (Stenopora) fibrosus*, *Encrinites*.

3. Band of pisolitic limestone, 2 feet (fossils).

4. Shale and concretionary limestone, 3 feet (fossils).

These are the undoubted Hirnant beds, and they are succeeded by:—

5. Band of soft decomposing grit, 2 feet (fossils).

6. Fossiliferous shales passing up into slaty shales.

7. Soft blue slaty shale, underlying the Tarannon shale.

These latter probably belong to the Silurian system.

Mr Ruddy states that the Hirnant grits are not less than 250 feet thick in the Hirnant valley.

Besides the above-named fossils the following occur:—

Orthis testudinaria

Arca Edmondiiformis

Modiolopsis modiolaris.

The *Orthis hirnantis* is the most important fossil.

SILURIAN SYSTEM.

May Hill Series. The May Hill series of North Wales consist of three well-marked stages, a grit at the base, black shales in the centre, and pale green shales above. The grit series varies considerably in character, and rests unconformably upon the underlying Cambrian system, so that the Silurian base sometimes reposes on Upper Bala, at other times upon Middle Bala beds. The suspicion that the upper grits of the Hirnant district may be of this age has been already alluded to; at Corwen, Prof. Hughes has described (*Q. J. G. S.* xxxiii. p. 207) coarse quartzose grits, about 50 feet thick, apparently unfossiliferous, under the name of the Corwen grits. At Cerrig-y-druidion, these grits are interstratified with finer shaly bands. At Cynr-y-brain, the grits are fossiliferous, and contain well-known May Hill species as *Meristella crassa*. *Pentamerus oblongus* is recorded from Cerrig-y-druidion and must come from May Hill beds. The black shales contain graptolites, which are all of species to be subsequently mentioned as occurring in the shales of Birkhill, S. Scotland, e. g.

Monograptus convolutus var. *communis*

M. Sedgwickii?

M. tenuis

M. gregarius

Climacograptus normalis ?

Professor Hughes has discovered a graptolitic fauna belonging to the same stage in Anglesea, on Paris Mountain. He records (*Q. J. G. S.* xxxviii. p. 27).

Rastrites (*Monograptus*) *triangulatus*

Monograptus gregarius

M. alternatus

Diplograptus tamariscus

D. acuminatus

D. modestus

Climacograptus rectangularis

C. normalis.

The third stage of the series, the pale green (the so-called Tarannon) shales, has yielded graptolites to Prof. Lapworth in the cliffs opposite Conway Castle. He found (Cf. *Distribution of Rhabdophora*, p. 39):—

Climacograptus normalis

M. Becki

Diplograptus palmeus

M. galaensis

Retiolites Geinitzianus

M. Sedgwicki

Monograptus priodon

M. fimbriatus

M. exiguus

M. turriculatus.

M. Halli

Salopian Series. To this group belong the Denbighshire Grits and Flags, occupying large areas around the Vales of Dee and Clwyd.

They consist of the following stages:—

1. Blue flaggy slates (Pen-y-glog quarry, &c.).
2. Coarse grits (top of Pen-y-glog quarry).
3. Llansannan shales.
4. Coarse grits (only seen in Clwyd valley).

Sir A. Ramsay gives the thickness of the shaly and concretionary rocks of the base (apparently 1 of above section) at 1700 feet, and of the flaggy and sandy strata (probably 2 and 3) at 3000 feet.

Fossils of 1.

Monograptus priodon

M. Halli

<i>M. vomerinus</i>	<i>Orthoceras primævum.</i>
<i>Cyrtograptus Murchisoni</i>	<i>Retiolites Geinitzianus</i>
<i>Acroculia haliotis</i>	<i>Cardiola interrupta</i>

Fossils of 2.

<i>Favosites fibrosus</i>	<i>O. biloba</i>
<i>Calymene Blumenbachii</i>	<i>Rhynchonella nucula</i>
<i>Phacops caudatus</i>	<i>R. borealis</i>
<i>P. Downingiæ</i>	<i>Spirifera plicatella</i>
<i>Beyrichia Klødeni</i>	<i>S. elevata</i>
<i>Orthis elegantula</i>	

Characteristic Fossils of 3.

<i>Favosites fibrosa</i>	<i>Cardiola interrupta</i>
<i>Tentaculites ornatus</i>	<i>C. striata</i>
<i>Actinocrinus pulcher</i>	<i>Holopella gracilior</i>
<i>Atrypa reticularis</i>	<i>Orthoceras laqueatum?</i>
<i>Rhynchonella Wilsoni</i>	<i>O. tenuicinctum</i>
<i>R. navicula</i>	<i>O. tracheale</i>
<i>R. nucula</i>	<i>Cycloceras ibex.</i>

No fossils are recorded from 4.

The abundance of *Cardiola interrupta* is to be noted. It occurs on the same horizon in many parts of Europe.

No higher Salopian beds, and no Downtonian beds occur in North Wales, partly perhaps owing to subsequent denudation, but as the highest beds seen shew signs of having been deposited in shallow water, it is probable that the period of deposition during Silurian times came to an end in the North Welsh area much sooner than in the area to the south-east.

Having now described the North Welsh area, where the typical Cambrian beds are seen, it will be convenient to consider next the area where the Silurian system has its typical development, viz.:—

2. *The Welsh Borders.*

CAMBRIAN SYSTEM.

Harlech Series. The rocks of this series are found in the Longmynd Hills of Shropshire, where they consist of green and

purple grits, and conglomerates, with slaty beds. Their thickness is given at 8000 feet. Fossils:—

Arenicolites didymus

A. sparsus

Palæopyge Ramsayi.

Menevian Series. The fossils characteristic of the Menevian beds have not been detected in this area, and any rocks of this epoch which may have been deposited in the area at this period have not yet been distinguished.

Lingula Flag Series. Beds of this epoch occur resting against the Precambrian rocks of the Malvern Hills. Two divisions or stages:—

1. Hollybush Sandstone, greenish or brownish sandstone, with conglomerate at the base; maximum thickness, 600 feet. Fossils:—

Scolecoderma antiquissima

Lingula

Kutorgina cingulata.

2. Malvern Shales, blackish shales, 500—1000 feet thick. Fossils:—

Dictyonema sociale

Peltura scarabæoides

Agnostus trisectus

Sphærophthalmus alatus.

The Hollybush Sandstone also occurs near the Wrekin, where it contains *Kutorgina cingulata*, but there is no representative of the Malvern Shales.

Tremadoc Series. In South Shropshire, Mr Callaway has discovered a Tremadoc fauna in the Shineton shales, "dark blue, weathering to olive and yellow,.....micaceous, thin-bedded, soft, and rather fissile.....At the top of the series..... the shales become more arenaceous, and thicker-bedded" (*Q. J. G. S.* xxxiii. p. 657). Thickness estimated at not less than 1500 feet. Fossils:—

Dictyonema sociale

Olenus Salteri

Clonograptus

Conophrys salopiensis

Bryograptus Callavei

Theca lineata

Asaphus Homfrayi

Bellerophon shinetonensis.

Euloma ? monile

Arenig Series. In the neighbourhood of Shelve in Shrop-

shire, true Arenig shales occur. Prof. Lapworth records *Phyllograptus*, *Didymograptus*, and *Trigonograptus* from the lowest zones of the Bog Mine, and records the finding by Mr Hopkinson of *Didymograptus patulus*, and *Clematograptus implicatus*.

Llanvirn Series. These beds are considered by Dr Hicks to occur at Shelve, and the following fossils given in *Siluria*, p. 48, seem to be referable to this horizon :—

<i>Didymograptus Murchisoni</i>	<i>Trinucleus Murchisoni</i>
<i>D. geminus</i>	<i>Obolella plumbea</i>
<i>Ægolina binodosa</i>	<i>Redonia anglica</i>
<i>Ogygia Selwynii</i>	<i>Ribeiria complanata</i>
<i>Illænus perovalis</i>	<i>Orthoceras Avelinii</i>

The graptolites are very characteristic of Llanvirn beds.

Lower Bala (Llandeilo) Series. Murchison (*Siluria*, p. 50) describes the lower strata of the Stiper-stones passing up into “a thick succession of flagstones of dark-grey and light-blue colours, in part calcareous, such as those which compose the chief mass of the Llandeilo series.” Fossils :—

Asaphus tyrannus
Ogygia Buchii
Trinucleus, &c.

Middle Bala Series. In some places arenaceous, in others argillaceous, the arenaceous type is known as Caradoc Sandstone. The following subdivisions given by Messrs Aveline and Salter in descending order :—

5. Thin bedded sandy *Trinucleus* shales (*T. concentricus*).
4. Fossiliferous brown and yellow sandstones.
3. Thick freestone beds (Horderley Flags).
2. Coarse yellow sandstone (Hoar Edge Grits).
1. Sandy argillaceous shales.

Argillaceous type found in South Shropshire, its subdivisions are :—

3. Chatwall sandstone with *Orthis alternata*.
2. Harnage shales.
1. Hoar Edge Grits.

Fossils :—

Diplograptus pristis *Beyrichia complicata*

Trinucleus concentricus	O. vespertilio
Orthis testudinaria.	O. flabellulum.
O. alternata	

Upper Bala Series. Not distinctly made out.

SILURIAN SYSTEM.

May Hill Series. In this area, the land seems to have been submerged at the commencement of the Silurian times, somewhat later than in the areas further south, so that only higher beds of the May Hill series are found. They occur in Shropshire, Gloucestershire, Worcestershire, &c., resting upon different members of the lower system, and consist usually of calcareous sandstones, with conglomerates at the base, the sandstones usually being of a yellowish, sometimes greyish colour, succeeded by purple shales, the average thickness being about 1000 feet. Fossils:—

Petraia bina	Pentamerus globosus
Lindstroemia subduplicata	P. oblongus
Tentaculites anglicus	P. undatus
Acidaspis Brightii	Stricklandinia lens
Encrinurus punctatus	S. lirata
Cyphaspis megalops	Rhynchonella nucula
Phacops imbricatus	Strophomena euglypha
Atypa reticularis	Pterinea retroflexa
A. imbricata	Bellerophon trilobatus
Meristella crassa	Phragmoceras ventricosum.
Orthis reversa	

Monograptus priodon is recorded from May Hill in the *Survey Memoirs*. In other areas it has not been found lower than the representatives of the uppermost portion of the May Hill series (the Tarannon shales).

The Salopian Series. Professor Lapworth makes this subdivision to include "Murchison's Great Mudstone series, which includes the so-called Wenlock and Lower Ludlow groups, as high as the horizon of the Aymestry Limestone." It consists of a series of shales, with lenticular masses of limestone of varying thickness, and the following are the subdivisions in ascending order:—

1. Woolhope and Barr Limestone.
2. Wenlock Shales.
3. Wenlock Limestone.
4. Lower Ludlow Shales.

The thickness of the whole is about 1700 feet. Of the numerous fossils found in this area, the following may be selected as very characteristic.

From 1 and 2:—

<i>Cyrtograptus Murchisoni</i>	<i>Retzia Barrandii</i>
<i>Phacops caudatus</i> var. <i>corrugatus</i>	<i>Strophomena omalensis</i>

From 3:—

<i>Dictyonema retiformis</i>	<i>Cyrtia exporrecta</i>
<i>Omphyma turbinata</i>	<i>Meristella Circe</i>
<i>Crotalocrinus rugosus</i>	<i>Retzia Barrandii</i>
<i>Taxocrinustesseracontadactylus</i>	<i>Rhynchonella borealis</i>
<i>Pseudocrinites quadrifasciatus</i>	<i>R. Wilsoni</i>
<i>Turrilepas Wrightianus</i>	<i>Pentamerus galeatus</i>
<i>Lichas anglicus</i>	<i>Avicula mira</i>
<i>Sphærexochus mirus</i>	<i>Grammysia cingulata</i>
<i>Homalonotus delphinocephalus</i>	<i>Conularia Sowerbyi</i>
<i>Proetus Stokesii</i>	<i>Euomphalus funatus</i>
<i>Acidaspis crenatus</i>	<i>Phragmoceras ventricosum</i>
<i>Lingula Lewisii</i>	<i>Gomphoceras pyriforme</i>

From 4:—

<i>Monograptus colonus</i>	<i>Pentamerus Knightii</i> var. <i>elongatus</i>
<i>M. leintwardinensis</i>	<i>P. galeatus</i> var.
<i>M. Roemeri</i>	<i>Ambonychia striata</i>
<i>Protaster Miltoni</i>	<i>Acroculia euomphaloides</i>
<i>Ceratiocaris robustus</i>	<i>Murchisonia Lloydii</i>
<i>Pterygotus arcuatus</i>	<i>Orthoceras perelegans</i>
<i>Slimonia punctata</i>	<i>Trochoceras giganteum</i>
<i>Phacops Stokesii</i>	
<i>Spirifer trapezoidalis</i>	

Downtonian Series.

1. Aymestry Limestone, 30—40 feet.
2. Upper Ludlow Bed. "Flaggy arenaceous shale, with beds of thin shelly limestone." 140 feet.

3. Downton sandstones; "light-coloured, thin-bedded, and slightly micaceous sandstones," with a bone bed at the base; 100 feet at Malvern.

4. Ledbury shales; "red, grey, and purple marls, shales, and sandstones:" about 250 feet, passing upwards into the Old Red Sandstone, some of which should certainly be included in this series. Downtonian Fossils:—

<i>Serpulites longissimus</i>	<i>Strophomena filosa</i>
<i>Pterygotus problematicus</i>	<i>Chonetes lata</i>
<i>P. Banksii</i>	<i>Orthonota amygdalina</i> var. <i>retusa</i>
<i>Beyrichia Klœdeni</i>	<i>Platyschisma helicitæ</i>
<i>Discina rugata</i>	<i>Bellerophon expansus</i>
<i>Lingula cornea</i>	<i>Orthoceras bullatum</i>
<i>Rhynchonella nucula</i>	<i>Onchus tenuistriatus</i>
<i>Orthis lunata</i>	

3. *Central Wales.*

The beds of this area are described by Mr Walter Keeping (*Q. J. G. S.* vol. xxxvii. p. 141). They all belong to the Silurian System.

May Hill Series.

1. Aberystwith Grits: "hard, compact, dark grey grit or greywacke, and dark shales, rabs, and imperfect slates in strikingly regular alternation." Cefn Hendre and Devil's Bridge, &c. Thickness estimated by Mr Keeping at not less than 1000 feet. Fossils:—

<i>Monograptus Sedgwickii</i>	<i>Dictyonema delicatulum</i>
<i>M. Clingani</i>	<i>D. venustum</i>
<i>M. lobiferus</i>	<i>Odontocaulis Keepingi</i>
<i>M. turriculatus</i>	<i>Phacops elegans</i>
<i>Calyptragraptus (?) plumosus</i>	<i>Nereites Sedgwicki</i>
<i>Rhizograptus (?) digitatus</i>	<i>Myrianites tenuis</i>

2. The Metalliferous Slates. Mr Keeping applies the terms "indurated shaly slate," "irregular slate," "flaggy slate," "hard pale slate-rock often much jointed," "pale slate with ribbon bandings" to this rock. He estimates the group at not less than 2000 feet thick. Fossils:—

Rastrites peregrinus	M. runcinatus
R. maximus	M. Hisingeri
Monograptus Sedgwickii	M. tenuis
M. cyphus	M. involutus
M. gregarius	Diplograptus Hughesii
M. intermedius	D. palmeus
M. Clingani	Climacograptus normalis
M. spiralis	Nereites Sedgwickii
M. lobiferus	Myrianites McLeayi.

Professor Lapworth considers from the fossil evidence that the metalliferous slates should be below the Aberystwith grits, and during a hasty traverse over the area I was much struck with the resemblance of the Devil's Bridge beds (Aberystwith grits) to the Tarannon shales, and of the Morben beds at Mac-hynlleth to the Birkhill group, the distinction being that the Central Welsh beds are shallower-water deposits.

Salopian Series (?). Plynlimmon group. Coarse grits with "a profusion of felspar crystals, and large blebby quartz grains." The group is however "still, in the main, a slate series, some of the slate being pale and papery." Mr Keeping considers 1000 feet an under-estimate of their thickness. No fossils have been found in situ.

4. *South Wales.*

CAMBRIAN SYSTEM.

(Cf. Hicks, *Pop. Sci. Rev.* N. S. vol. v.)

Harlech Series, rests unconformably upon Precambrian rocks. Divided by Hicks into two groups, the lower of which he terms Caerfai, and the upper, the Solva.

Caerfai Group.	Upper, 1000 feet. Purple Sandstones with Anne- lids, &c.
	Middle, 50 feet. Red Shales and Schists, with Leperditia Cambrensis, Lingulella primaeva, Discina caerfaiensis, &c.
	Lower, 520 feet. Conglomerates and Greenish Flaggy Sandstones, with Annelids, Fucoids, &c.

Solva Group.	{	Upper, 150 feet. Grey Rocks with <i>Paradoxides aurora</i> .
		Middle, 1500 feet. Grey, purple and red Rocks, with <i>Paradoxides solvensis</i> , <i>Conocoryphe solvensis</i> , &c.
		Lower, 150 feet. Yellowish Grits, Sandstones, and Flags with <i>Paradoxides Harknessi</i> , <i>Plutonia Sedgwickii</i> , and also <i>Eophyton</i> , large <i>Fucoids</i> , &c.

Menevian Series. The Solva beds gradually pass into the Menevian, the beds assuming a deeper-water character, and becoming darker. Subdivided by Dr Hicks into:—

“Upper, 100 feet. Sandstones and Shales, with *Orthis Hicksii*, &c.

Middle, 350 feet. Flags and Slates, with *Paradoxides Davidis*, &c.

Lower, 300 feet. Grey Flags, with *Paradoxides Hicksii*, &c.”

Other Fossils:—

<i>Protospongia fenestrata</i>	<i>Erinnys venulosa</i>
<i>Microdiscus punctatus</i>	<i>Anoplenus Henrici</i>
<i>Holocephalina primordialis</i>	<i>Arionellus longicephalus</i>
<i>Conocoryphe variolaris</i>	<i>Theca corrugata</i> , &c. &c.

Lingula Flag Series. This series is not well developed in the St David's area. It is “a series of sandstones and shales, occasionally ripple-marked. Very barren for the most part, and showing a return to shore deposits.” Only the lower (*Maentwrog*) and middle (*Ffestiniog*) divisions of the series are here seen, the upper (*Dolgelly*) division on the other hand being the only one found in the Malvern area, whilst the three occur in North Wales. The characteristic *Lingulella Davisii* is found in the St David's area.

Tremadoc Series. The Tremadoc rocks of St David's are said by Dr Hicks to have been deposited under conditions intermediate between the “shallow water of the *Lingula Flag* and the deep water of the succeeding *Arenig* series, and under the circumstances it is not surprising to find their fauna very different from that which characterises the Tremadoc rocks in other places. The rich lamellibranch fauna is particularly

noticeable. The beds represent only the Lower Tremadoc rocks of North Wales, according to Dr Hicks. The following are some of the fossils :—

Neseuretus ramseyensis and three other sp.	Ctenodonta menapiensis
Niobe solvensis	Glyptarca primaeva
N. menapiensis	Modiolopsis ramseyensis
Bellerophon ramseyensis	Orthis Carausii
Palasterina ramseyensis	O. menapiae.

Arenig Series. The Lower Arenig of St David's consists of fine black slates and shales, with a thickness of about 1000 feet. Some of the fossils are here given :—

Didymograptus extensus	Dictyonema Homfrayi
D. pennatulus	Asaphus Homfrayi
Phyllograptus stella	Ogygia scutatrix
Trigonograptus ensiformis	Lingulella Davisii
Dendograptus flexuosus	Orthis lenticularis
Callograptus radiatus	Conularia Homfrayi.

Dr Hicks correlates this, as before stated, with the Upper Tremadoc rocks of North Wales, and the resemblance in the fossils is striking.

Upper Arenig of St David's consists of slates and flags, with narrow bands of sandstones intercalated, about 1500 feet thick, and represented wholly or in part by the Garth Grit of North Wales. Some of the fossils are :—

Didymograptus patulus	Ogygia peltata
Tetragraptus serra	Trinucleus Gibbsii
Callograptus elegans	Theca Harknessi
Agnostus hirundo	Orthoceras sericeum
Ampyx Salteri	Bellerophon multistriatus.
Æglina grandis	

Llanvirn Series. At St Davids, this series is composed of dark slates and shales, with beds of contemporaneous volcanic tuff, the whole being about 2000 feet thick. Well seen at Llanvirn, where it has yielded many fossils to Dr Hicks.

<i>Æglina obtusicaudata</i>	<i>Conularia llanvirkensis</i>
<i>Barrandea Homfrayi</i>	<i>Orthoceras Avelinii</i>
<i>Calymene parvifrons</i> var. <i>Murchisoni</i>	<i>Didymograptus bifidus</i>
<i>Ilæenus Hughesii</i>	<i>D. indentus</i>
<i>Ilænopsis ? acuticaudata</i>	<i>D. Murchisoni</i>
<i>Placoparia cambriensis</i>	<i>D. patulus</i>
<i>Phacops llanvirkensis</i>	<i>Climacograptus confertus</i>
<i>Trinucleus Ramsayi</i>	<i>Diplograptus dentatus</i>
	<i>Glossograptus ciliatus</i> .

Lower Bala Series. Sir R. I. Murchison described beds belonging to this series in the Llandeilo area, under the name of the Llandeilo beds. They however belong to Sedgwick's Lower Bala Series, and the name Llandeilo is associated with so great errors that it cannot be adopted. Its stratigraphical position was mistaken, and beds of all ages were referred to it by Murchison merely because they contained graptolites. It consists at Llandeilo of dark shales with interbedded sandstones, followed by calcareous grits, succeeded by shales with *Asaphus tyrannus*, and over these are calcareous flagstones and shales. In Pembrokeshire the lower stage of the series consists of calcareous shales and flags with *Asaphus tyrannus*, &c., 800 feet thick, and the upper of black slates, flags, and flaggy sandstones with *Ogygia Buchii*, &c., over 1000 feet in thickness. The beds which Dr Hicks described in 1875 as Lower Llandeilo, occurring on the south side of Abereiddy Bay, are now included by him in the Llanvirk series. Fossils of the Lower Bala rocks:—

Lower Stage.

<i>Dicellograptus moffatensis</i>	<i>Leptæna sericea</i>
<i>Asaphus tyrannus</i>	<i>Bellerophon perturbatus</i> .
<i>Trinucleus Lloydii</i>	

Upper Stage.

<i>Agnostus M'Coyi</i>	<i>Cheirurus Sedgwickii</i>
<i>Ampyx nudus</i>	<i>Ogygia Buchii</i>
<i>Barrandea Cordai</i>	<i>Bellerophon perturbatus</i> .
<i>Calymene duplicata</i>	

At St Clear's, near Carmarthen, the following fossils are recorded by Prof. Lapworth :—

Dicranograptus formosus
Diplograptus foliaceus
Climacograptus perexcavatus.

Middle Bala Series. Rocks of this age occur in South Wales, and one of the most prolific localities is Sholeshook, near Haverfordwest, which has yielded characteristic Middle Bala Fossils, as :—

Sphæronites stelluliferus	Trinucleus seticornis
Cybele Loveni	Remopleurides radians
Lichas laxatus	Stygina latifrons.

From a railway-cutting near Cynghordy station Prof. Lapworth records :—

Diplograptus foliaceus
Climacograptus bicornis
Dicellograptus Forchhammeri.

Upper Bala Series. No lists of fossils from Upper Bala of South Wales have been given by McCoy or others.

SILURIAN SYSTEM.

May Hill Series. A very variable series, consisting of conglomerates, sandstones and shales, derived from the denudation of the rocks of the Cambrian system, to which they are unconformable. Local unconformities are recorded between the Upper and Lower stages of this series, as might be expected from the nature of the deposits. Such is the character of the unconformity between the Red and Coralline Crags, which has no significance when considering the classification of the larger rock-groups. The series is of variable thickness, but at Llandovery itself, as also in Pembrokeshire, it is over 2000 feet in thickness. Fossil lists from these rocks differ very much, partly perhaps owing to the record of Upper Bala species in some of the lists, partly owing to the recording of remanié forms, and to those causes to which I have referred in the introduction

as likely to affect the fossil lists of beds at the extreme base of a system. Under these circumstances it will be as well to give a list of the fossils recorded from this series at Llandovery itself, firstly in the lower, and secondly in the upper stage marking those which are common to the two stages. This list is drawn up from the specimens in one collection only, viz.—that of the Woodwardian Museum.

Lower Stage.

Ischadites	Orthis alata ?
Nebulipora	O. elegantula
Favosites fibrosa	O. biloba
F. gothlandica	O. calligramma
F. alveolaris	O. plicata
Heliolites megastoma	O. protensa
H. tubulata	O. insularis
H. interstincta	O. vespertilio
H. petalliformis	Strophomena depressa
Halysites catenularius	S. depressa var. tenuistriata
Lindstroemia subduplicata	S. antiquata
L. subduplicata var. crenulata	S. pecten
Phyllopora Hisingeri	S. arenacea
Pleurocystites Rugeri ?	Leptaena transversalis
Tentaculites	L. sericea
Serpulites	Orthonotus
Phacops elegans ?	Ctenodonta Hughesii
P. Stokesii ?	Murchisonia Lloydii
Calymene Blumenbachii	M. sulcata
C. brevicapitata ?	Loxonema
Encrinurus punctatus	Cyclonema crebristria
Atrypa marginalis	C. n. sp. ?
A. reticularis	Macrocheilus pupa
A. hemisphaerica	Pleurotomaria balteata
Lingula	P. Bechei
Meristella crassa	Euomphalus ?
Stricklandinia lens	Bellerophon dilatatus
Pentamerus oblongus	B. ventriculus
P. undatus	Trochoceras cornu-arietis,

Upper Stage.

Stromatopora striatella	P. globosus
*Favosites fibrosa	*P. undatus
*F. alveolaris	Meristella
*Heliolites interstincta	*Orthis insularis
*Halysites catenularius	*O. protensa
Petraia rugosa	*O. biloba
P. elongata	*O. elegantula
P. bina	*O. calligramma
P. uniserialis	*Strophomena depressa
*Lindstroemia subduplicata	*S. antiquata
*Encrinurus punctatus var.	*Leptæna transversalis
arenaceus	*L. sericea
Homalonotus ?	L. scissa
Prætus Stokesii	Conularia Sowerbyi
Lingula	Acroculia
*Atrypa reticularis	Murchisonia angulata
Athyris obovata	Cyclonema
*Pentamerus oblongus	Orthoceras.

It will be seen that nearly seventy per cent. of the species occurring in the upper stage are found also in the lower in this one area, shewing that the Lower May Hill beds ought certainly to be included within the same system as the upper, and that they in truth form stages of one series.

Salopian Series. Beds belonging to this series occur in various parts of South Wales. They have been described by Prof. Sollas in the neighbourhood of Cardiff (*Q. J. G. S.* xxxv. p. 475), and amongst others, the following fossils occur there:

Omphyma turbinata	Rhynchonella Wilsoni
Bellerophon wenlockensis	Phacops caudatus
Euomphalus sculptus	Illaenus Barriensis
E. funatus	Tentaculites ornatus.
Pentamerus galeatus	

From the base of the Salopian Series near Builth, Professor Lapworth records the following graptolites, which were found in calcareo-carbonaceous shales:—

Monograptus priodon	M. colonus
M. Halli	Cyrtograptus Murchisoni
M. vomerinus	Retiolites Geinitzianus.

Downtonian Series. Beds of this series are described by Prof. Sollas in the Cardiff area, consisting of greyish and brownish mudstones passing up into beds referred to the Old Red Sandstone: some of the fossils are: .

Rhynchonella nucula	Pterinea Sowerbyi
R. borealis	Mytilus mytilimeris
Spirifer elevatus	Murchisonia Lloydii
S. plicatellus var. radiatus	Phacops caudatus.
Chonetes striatella	

And higher up in the series a bone bed with *Onchus tenuistriatus*.

5. Cornwall.

CAMBRIAN SYSTEM.

Llanvirn Series? Professor Sedgwick obtained from hard quartzites at Carn Goran, in S. Cornwall;

Calymene Tristani
Strophomena sp.
Orthis sp.

The first-named fossil occurs in Brittany along with *Placoparia* and other Llanvirn fossils.

6. The Lake District. (Including Craven and Pennine Areas.)

CAMBRIAN SYSTEM.

Lingula Flag Series? The base of the Cambrian System is not seen in the Lake District, and the oldest beds were described by Prof. Sedgwick as the Skiddaw Slates. They have been subdivided by the Rev. J. C. Ward on lithological grounds, and he considers the *Lingula Flag* series to be represented by the lowest rocks he has found, viz.,—the thick-bedded sandy and gritty series of Grasmoor and Whiteside, but no fossils have been found in those beds.

Tremadoc Slate Series? Above the last-named grits are placed black iron-stained slates, which have yielded fossils viz. :—Niobe Doveri and Cybele ovata.

Arenig Series. The black iron-stained slates are succeeded by a coarse grit, seen around Skiddaw, and supposed by Mr Ward to represent the Garth Grit of North Wales, and above it come the true Skiddaw slates, consisting of black, badly cleaved clay slates. The thickness of the Skiddaw slates is estimated by Prof. Harkness at 7000 feet. They have unfortunately not yet been carefully subdivided into zones, but a great bulk certainly represents the Arenig Series, as proved by the graptolites.

The following are some of the fossils :—

Dichograptus octobrachiatus	D. nitidus
Loganograptus Logani	D. patulus
Tetragraptus bryonoides	D. serratulus
T. crucifer	D. V-fractus
T. Headi	D. divaricatus
T. quadribachiatus	Lingula brevis
Phyllograptus angustifolius	Palaeochorda major
P. typus	Æglina caliginosa
P. Anna	Æ. binodosa
Trigonograptus lanceolatus	Agnostus Morei
Climacograptus antennarius	Phacops Nicholsoni
C. bicornis	Trinucleus Gibbsii
Diplograptus mucronatus	Caryocaris Wrightii.
Didymograptus bifidus	

Llanvirn Series? It is very probable that some of the fossils given in the above list belong to this rather than to the preceding series. Some of the higher Skiddaw slate beds under the Pennine Chain have yielded forms apparently belonging to the age of the Llanvirn deposits. At Ellergill, near Milburn, for instance, Prof. Lapworth records :—

Didymograptus bifidus	D. geminus
D. patulus	Diplograptus tricornis.

But they are mingled with true Arenig forms, as Phyllo-

graptus and Trigonograptus: the beds are probably intermediate between the two series.

Lower Bala Series. A series of andesitic lava flows, agglomerates and ashes of green colour, about 12,000 feet thick, known as the Borrodale series (the Green Slates and Porphyries of Sedgwick), belong in the lower part to this series. They are considered by Mr. Ward and others to have accumulated chiefly on land, being formed solely by the piling-up of volcanic ejectamenta. No fossils have been found. At Chapel-le-dale in Yorkshire, green unfossiliferous slates of marine origin, supposed by Prof. Hughes to be 10,000 feet thick, represent the volcanic beds of the Lake District proper.

Middle Bala Series. The upper part of the Borrodale beds belong to this series. In the Pennine Area the volcanic beds are not greatly developed, and they are replaced towards the summit by about 300 feet of black deep-water shales (Dufton Shales, Harkness and Nicholson), with graptolites not yet determined, and other organisms of undoubted Middle Bala age, as:—

Calymene Blumenbachii	Strophomena expansa
Trinucleus seticornis	Orthis testudinaria
Cybele Loveni	Trematis corona
Illænus Bowmanni	Lingula ovata
Leptaena transversalis	L. tenuigranulata.
L. sericea	

These shales are succeeded by Coniston Limestone, about 200 feet of limestone bands and calcareous shales, or in places, as at Keisley, of white and pink crystalline limestone. Fossils:—

Heliolites interstincta	spina.
Streptlesma (?) æquisulcatum	P. (C.) Eichwaldi
Syringophyllum organum	Calymene senaria
Diplograptus	Illænus Davisii
Beyrichia strangulata	I. Rosenbergi
Harpes Doranni	Orthis calligramma
Trinucleus seticornis	O. flabellulum
Cybele Loveni	O. insularis
Phacops Brongniartii	O. vespertilio
Phacops (Chasmops) brevis	Trochoceras cornu-arietis.

Upper Bala Series. The Ashgill Shales of Sedgwick and Salter succeed the Coniston Limestone, and have a very different fauna. They are never more than 200 feet thick, and consist of a lower stage of grey crystalline limestone, succeeded by poorly cleaved bluish or blackish shales. Fossils:—

*Caryocystites Davisii	Orthis biforata
*Turrilepas	O. protensa
Trinucleus concentricus	O. vespertilio
*Staurocephalus clavifrons	O. testudinaria
*Phacops apiculatus	Strophomena Siluriana
*P. eucentra	*Holopea concinna
Cornulites	*Orthoceras vagans.

The species which also occur in the lower stage are marked (*).

SILURIAN SYSTEM.

May Hill Series. Consists of three stages, the lower, (i) A series of gritty and conglomeratic beds, often calcareous, resting unconformably upon the beds of the lower System. (ii) A series of black shales deposited in deep-water, and usually graptoliferous. (iii) Pale green and purple shales, the equivalents of the Tarannon shales of Wales. (i) and (ii) must be correlated with both Upper and Lower Llandovery (May Hill) of the Welsh area. The thickness of the whole is about 250 feet in places. The beds appear to have been deposited in somewhat shallower water in parts of the Craven area (Austwick), but are otherwise similar.

Fossils of (i)	O. sagittifera
Favosites fibrosus	Strophomena Siluriana?
Illænus?	Meristella crassa
Orthis protensa?	Atrypa altijugata?
O. biforata	Ctenodonta anglica.

Professor Lapworth subdivides the beds of (ii) the "Coniston Mudstones" into two zones, and records from the lower (*tenuis*) zone the following amongst other graptolites:—

Diplograptus folium	Climacograptus normalis
D. confertus	Retiolites perlatus.

Monograptus spiralis	M. cyphus
M. Sedgwickii	Rastrites peregrinus.
M. tenuis	

From the higher (*argenteus*) zone :—

Diplograptus Hughesii	M. lobiferus
Climacograptus normalis	M. attenuatus
Rastrites peregrinus	M. leptotheca.
Monograptus Hisingeri	

Besides graptolites, the following fossils occur in the lower zone, chiefly in non-graptoliferous beds :—

Petraia	Encrinurus variolaris
Acidaspis	Leptaena quinquecostata.
Cheirurus bimucronatus ?	

And in the higher zone :—

Discinocaris Browniana	Phacops elegans
Peltocaris aptychoides	Ampyx Roualti ?
Acidaspis granulatus	Leptaena quinquecostata
Harpes	Orthoceras araneosum.
Cheirurus bimucronatus ?	

In black seams in the Pale shales

Monograptus Becki,
M. turriculatus,
M. priodon,

occur in Stockdale, and Professor Lapworth records a Monograptus allied to M. Halli in similar beds in the Pennine district.

Salopian Series. About 12,000 feet thick in the Lake District, and consists of shales (more or less cleaved in different localities), flagstones and grits.

Stages. Brathay flags, the zone of Cyrtograptus Murchisoni, fine blue cleaved flags with abundance of

Monograptus priodon	Cyrtograptus Murchisoni
M. vomerinus	Retiolites Geinitzianus
M. Halli	Peltocaris anatina.

(ii) Coldwell beds, gritty at the base, and succeeded by more flaggy beds. Fossils:—

Monograptus colonus	Acidaspis Hughesii
M. bohemicus	Cardiola interrupta
M. Roëmeri	Orthoceras primævum
Actinocrinus pulcher	O. dimidiatum
Ceratiocaris Murchisoni	O. originale
Phacops obtusicaudatus	O. elongatocinctum
P. torvus	O. recticinctum.
P. Stokesii	

(iii) Coniston Grits, with a band of intercalated flags containing Monograptus Roëmeri, Cardiola interrupta, and Orthoceras primævum at Laterigg Cottage, Troutbeck.

(iv) Bannisdale Slates, false-bedded and ripple-marked sandy flags, badly cleaved, with few fossils.

Downtonian Series. Consists principally of coarse grey grits, with calcareous fossil bands: a calcareous band at the base with star-fish, correlated by Mr Aveline with the Aymestry Limestone, containing:—

Ichthyocrinus McCoyanus	Palæaster hirudo
Taxocrinus Orbigny	Calymene tuberculosa
Palasterina primæva	Proetus latifrons.
Palæaster Ruthveni	

Above this, the beds are known as Kirkby Moor Flags: over 2000 feet thick, flaggy towards the higher portions, the uppermost beds removed by denudation, so that no information concerning the relationship of the Silurian System to that of the Old Red Sandstone can be here obtained. Fossils are very abundant, but the following are some of the more characteristic:—

Spongarium interlineatum	Pterygotus sp.
Tetragonis Danbyi	Lingula cornea
Beyrichia Klødeni	Discina rugata
Ceratiocaris inornatus	Spirifera elevata
C. solenoides	Rhynchonella nucula
Eurypterus	Orthis lunata.

Chonetes lata	Grammysia cingulata
Avicula Danbyi	Conularia Sowerbyi
Pterinea retroflexa	Murchisonia torquata
P. demissa	Cyclonema corallii
P. subfalcata	Holopea gregaria
Modiolopsis planata	Orthoceras Kendalense
Orthonotus amygdalinus	O. undulocinctum
O. truncatus	O. ludense
Ctenodonta anglica	Lituities ibex.

7. Teesdale.

CAMBRIAN SYSTEM.

Messrs Gunn and Clough describe rocks older than the Carboniferous as occurring in this area (*Q. J. G. S.* xxxiv. p. 27).

Middle Bala Series? Beds correlated with the Borrodale Series of the Lake District were found by these authors opposite Widdy-bank Farm, on the Yorkshire side of the Tees.

SILURIAN SYSTEM.

May Hill Series? Purple and greenish shales occurring at the Pencil Mill at Cronkley Scar are compared with the Pale Shales of the Lake District.

8. Isle of Man.

Cambrian System. The Rev. J. C. Ward has described the Skiddaw Slates of the Isle of Man. (*Geol. Mag.* Dec. II. vol. VII. p. 1). He was unable to trace any succession in them similar to that which he had previously made out in the Lake District, but found grit at Peel, and St Ann's Head. He could find no trace of equivalents of the Borrodale beds. Prof. Nicholson had previously recorded Palæochorda as occurring in the Skiddaw Slates of this island, as well as on the mainland. The beds are in fact physically speaking an isolated part of the Cumbrian beds.

9. Southern Scotland.

The beds of this area have been so admirably worked by

Prof. Lapworth, that it is impossible to do more than quote from his works on the districts. In his paper on "The Moffat Series" (*Q. J. G. S.* xxxiv. p. 240), he separates the beds of Dumfriesshire into three great groups by means of their graptolites, and these graptolite-bearing beds of South Scotland are still further separated into zones in his paper "On the Geological Distribution of the Rhabdophora" (*Ann. and Mag. Nat. Hist.* Ser. 5, vol. III.). Finally in a paper read before the Geological Society on June 7, 1882, Prof. Lapworth described the Girvan succession of Ayrshire, and correlated the beds of that district, often containing remains other than those of graptolites, with the beds of other areas.

CAMBRIAN SYSTEM.

When describing the geology of Anglesea, it was seen that a mass of pre-Cambrian land stood out above the Cambrian sea during the deposition of the lowest Cambrian rocks of Llanberis &c., and the same thing must have occurred in Scotland, the lowest beds being of Lower Bala age, and of a conglomeratic character, deposited against the shores of an old pre-Cambrian land. These beds are described by Prof. Lapworth in the Girvan area as the Barr Series, and are subdivided by him.

Lower Bala Series = Barr Series. 800—1000 feet thick.

1. Kirkland Conglomerate, coarse boulder-beds and sandstones usually purple.

2. Stinchar (or Craighead) Limestone. Compact limestones, nodular and calcareous flagstones and shales.

Maclurea Logani

Didymograptus

Ophileta

Clathrograptus.

Orthis confinis

3. Benan Conglomerate. Massive unfossiliferous boulder beds.

4. Balclatchie Beds. Highly fossiliferous pebbly grits and nodular shales, with *Lingula canadensis*, *Siphonotreta micula*, *Glossograptus*, &c.

In Dumfriesshire the Glenkiln or Lower Moffat shales are

of this age. No base is yet known. They consist of black graptolitic shales, with intermediate barren beds of varying texture. Amongst the fossils given by Prof. Lapworth are the following; those marked with an asterisk being also recorded by him as occurring in the Barr Series:—

Didymograptus superstes	Diplograptus foliaceus
Cœnograptus gracilis	*D. tricornis
*Leptograptus flaccidus	*D. dentatus
Dicellograptus sextans	*D. euglyphus
*Dicranograptus formosus	*D. angustifolius
*D. ramosus	*Climacograptus bicornis
Clathrograptus cuneiformis	*C. Scharenbergi
*Glossograptus Hincksi	C. perexcavatus.
Lasiograptus Harknessi	

Middle Bala Series = Ardmillan Series of the Girvan district, 1800—2000 feet thick, divided by Prof. Lapworth into stages.

1. Ardwell group. Dark graptolitic flagstones and shales, with *Dicranograptus*, *Leptograptus*, *Climacograptus*, &c.

2. Whitehouse group. Purple and green shales and mudstones, calcareous beds, with *Dionide*, *Dindymene Cordai*, *Æglina*, *Agnostus*, *Dicellograptus*, *Pleurograptus*.

3. Barren or Shallock Flagstones. Alternating grey or green flagstones and shales, generally unfossiliferous.

4. Drummuck group. Soft grey mudstones, &c., with *Trinucleus seticornis* var. *Bucklandi*, *Ampyx rostratus*, *Staurocephalus unicus*, *Dicellograptus*, &c.

In the Dumfriesshire area, the Ardmillan Series is represented by the Hartfell Shales, about 100 feet thick, lithologically similar to the Glenkiln Shales, but with more numerous dark fossiliferous shales, which are grouped together in a single mass.

The following is a list of some of the graptolites recorded by Prof. Lapworth, those marked with an asterisk occurring also in one or other of the divisions of the Ardmillan Series:—

<i>Pleurograptus linearis</i>	<i>Amphigraptus divergens</i>
<i>Leptograptus flaccidus</i>	<i>D. anceps</i>
* <i>Dicellograptus moffatensis</i>	* <i>D. Forchhammeri</i>

* <i>D. elegans</i>	* <i>C. tubuliferus</i>
<i>D. caduceus</i>	* <i>C. coelatus</i>
* <i>Dicranograptus ramosus</i>	* <i>C. Scharenbergi</i>
<i>D. Nicholsoni</i>	* <i>Diplograptus foliaceus</i>
<i>D. Clingani</i>	* <i>D. tricornis</i>
* <i>Idiograptus margaritatus</i>	* <i>D. truncatus</i>
<i>Retiolites fibratus</i>	* <i>D. quadrimucronatus</i>
* <i>Climacograptus bicornis</i>	* <i>D. socialis.</i>

SILURIAN SYSTEM.

May Hill Series. Professor Lapworth gives four stages referable to this series in the Girvan district, viz.—

- | | | |
|--|---|---|
| Newlands
Series
1000-1500
feet. | { | 1. Mulloch-Hill group, shelly sandstones, underlain by a coarse boulder conglomerate, and abounding in brachiopods; <i>Meristella angustifrons</i> , <i>Atrypa hemisphaerica</i> , <i>Nidulites favus</i> , &c. |
| | | 2. Saugh-Hill group, alternations of coarse pebbly grit and zones of black and grey shales, with a coarse conglomerate at the base. <i>Stricklandinia lens</i> , <i>Pentamerus oblongus</i> , <i>Favosites gothlandicus</i> , <i>Monograptus leptotheca</i> , &c. |
| | | 3. Camregan group, yellow thick-bedded grits and dark shales; calcareous band; <i>Pentamerus oblongus</i> , <i>Atrypa reticularis</i> , <i>Rastrites maximus</i> , <i>Monograptus Sedgwicki</i> . |
| | | 4. Penhill group, purple mudstones, grey flags, and greywackes with <i>Crossopodia</i> , <i>Protovirgularia</i> , &c. |

This is perhaps the most important development of this series in the British islands, for it contains beds, shewing the deep-water conditions of what we may speak of as the Birkhill type and containing a Birkhill fauna, interstratified with others exhibiting the shallow-water conditions of what we may term the Llandovery type, and containing fossils characteristic of both the upper and lower stages of the South Welsh area, e.g. *Nidulites favus*, and *Pentamerus oblongus* and *Stricklandinia lens*.

We shall find one or other of these types prevalent in widely separated areas, but they are seldom found alternating much with one another. Again in this area, these beds have at their summit, the representatives of the Taramon shales, viz:—the Penhill beds, with markings similar to those which occur in beds of the same age in Central Wales.

Professor Lapworth has here proved indisputably that the so-called Lower and Upper Llandovery beds must be included in the same series, and his conclusions are borne out by Mr Davidson, who in the discussion which followed the reading of Prof. Lapworth's paper upon the Girvan area, stated that "he found 15 species (of brachiopods) in the lower division (of this series), 29 in the middle, and 34 in the upper. Of these, six are common to the three divisions, 14 to the middle and upper division, 10 pass from the Caradoc into the Llandovery, and four species only seem to have passed upwards through the whole Girvan series, viz.—*Orthis calligramma*, *O. elegantula*, *Strophomena rhomboidalis*, and *St. corrugatella*. Thirty of the Llandovery species occur likewise in the Wenlock and Ludlow rocks. There is therefore a very marked difference between the species of Brachiopoda that characterise the Upper and Lower Silurian rocks of Great Britain." Although Mr Davidson here uses the Murchisonian nomenclature, he in reality adds another to the overwhelming number of arguments for adopting the classification of Prof. Sedgwick.

In the Dumfriesshire area, these beds are represented, the Newlands series by the Birkhill shales; and the Penhill group by the Gala rocks of the Eastern districts. The Birkhill shales have a total thickness of 140 feet in the typical area. The black fossiliferous shales are soft and irregularly laminated, the unfossiliferous mudstones are thin greyish-green or deep purple flaggy beds. Prof. Lapworth divides them into two stages, each separable into a number of zones. List of some of the characteristic fossils:—

Lower Stage.

<i>Diplograptus acuminatus</i>	<i>D. folium</i>
<i>D. vesiculosus</i>	<i>D. tamariscus</i>

Climacograptus normalis	M. cyphus
C. rectangularis	M. lobiferus
Monograptus tenuis	M. triangulatus
M. spiralis	M. leptotheca
M. argutus	Rastrites peregrinus.

Upper Stage.

Diplograptus tamariscus	M. tenuis
D. sinuatus	M. spiralis
D. Hughesii	M. lobiferus
D. palmeus	M. Clingani
Climacograptus normalis	M. Sedgwicki
Retiolites perlatus	M. gregarius
Monograptus runcinatus	Rastrites peregrinus
M. Halli	R. fugax.

The Gala group, the equivalent of the Tarannon shales, consists of greywacke with thin beds containing graptolites, amongst which are :—

Climacograptus normalis	M. Halli
Diplograptus palmeus	M. turriculatus
Retiolites Geinitzianus	M. priodon
Rastrites maximus	M. spiralis
Monograptus Sedgwicki	Cyrtograptus Grayæ.
M. Becki	

In fact this group, like the Tarannon shales, contains a mixture of Birkhill forms, with those occurring in the succeeding zone of *Cyrtograptus Murchisoni*.

Salopian Series. In the Girvan area the Penhill beds are succeeded by the Bargany group, pale flagstones, shales, and mudstones with *Retiolites Geinitzianus*, *Cyrtograptus Grayæ*, &c., and these by the Straiton group, grey flags, shales, and grits with *Beyrichia Klœdeni*, *Cardiola*, &c. the latter being correlated by Lapworth with Wenlock beds.

The zone of *Cyrtograptus Murchisoni* does not seem to have been discovered in Scotland, but in the basin of the Solway, beds of Salopian age, termed by Prof. Lapworth the Riccarton beds have yielded:

Retiolites Geinitzianus	M. riccartonensis
Cyrtograptus Carruthersi	M. vomerinus
Monograptus priodon	M. colonus.

Downtonian Series. Beds of this age occur in Lanark, at Lesmahagow, and have yielded numerous fossils :—

Dictyocaris Slimoni	P. perornatus
Ceratiocaris papilio	Slimonia acuminata
C. stygius	Mytilus mimus
Eurypterus lanceolatus	Platyschisma helicoides
Pterygotus bilobatus	Orthoceras Maclareni ?

Mr Etheridge also records a graptolite fragment from the Lower Old Red Sandstone of Lanarkshire.

10. *Northern Scotland.*

CAMBRIAN SYSTEM.

So many conflicting views prevail concerning the true succession of the rocks of the North of Scotland, that it is at present impossible to give a detailed description of the sequence. The similarity of the deposits with those of parts of Scandinavia is striking. In describing the beds of South Scotland it was seen that the oldest beds of the Girvan district were of Lower Bala age, resting against an old pre-Cambrian land. In Dalecarlia we shall ultimately see that the oldest beds are beds of red unfossiliferous false-bedded sandstones, succeeded unconformably by the conglomerates at the base of the Orthoceras Limestone of early Arenig or late Tremadoc age. These sandstones were probably accumulated in shallow seas or lakes at the period of greatest depression in Lower Cambrian times viz.—the Menevian period, and the pre-Cambrian land was again upraised in the succeeding period of the Lingula Flags. Is not the succession in Northern Scotland similar? The Torridon sandstone is lithologically similar to that of Dalecarlia before spoken of, and the Durness Limestone seems to be intermediate in character between the Orthoceras Limestone of Sweden and the Craighead Limestone of Girvan. A ridge of pre-Cambrian rock extends

through Central Scotland, and the lowest Girvan beds were deposited against it on the south, and the Durness Limestone on the north. The Durness Limestone is probably therefore homotaxial with the *Orthoceras* Limestone of Sweden, but of somewhat later date. Even in Scandinavia itself, the *Orthoceras* Limestone of various areas is probably of somewhat different age, being in places underlain, in others overlain by *Phyllograptus* Shales. In fact this part of Europe (Northern Scotland and Scandinavia), was situated near the higher pre-Cambrian land, and was the last to become submerged in Cambrian times. The pre-Cambrian granites and gneisses would form gently sloping undulating grounds, with isolated masses standing as islands in the ocean. Such land lay over the present N. Scotch and Dalecarlian areas in earliest Cambrian times, and underwent partial and temporary submergence probably in Menevian times, when the Torridon Sandstone and Dalecarlian Sandstone was deposited, and afterwards re-emerged. It again underwent depression, and the shallow-water *Orthoceras* Limestone with its associated conglomerate beds was deposited at somewhat different times in different places against the sinking land, consisting in some places of granitic and gneissic rocks, in others of later shallow-water sandstones. Amongst the fossils of the Durness Limestone are :—

<i>Maclurea Peachii</i>	<i>O. baculoides</i>
<i>Ophileta compacta</i>	<i>O. durinum</i>
<i>Orthoceras mendax</i>	<i>O. pertinens.</i>

11. *Ireland.*

The Cambrian and Silurian rocks of Ireland are in great part continuations of the rocks in the adjacent parts of Great Britain, merely separated by a strip of sea. The beds in many localities are still classified incorrectly, owing to the unfortunate correlation of graptolite-bearing shales of all ages with Llandeilo rocks. Thanks to the researches of Prof. Lapworth and Mr Swanston, an order of succession of these graptoliferous beds is established in some of the areas.

CAMBRIAN SYSTEM.

Harlech Series. Immediately opposite that part of North Wales which shows beds belonging to this series, they are also found in Ireland, and in lithological character these are very similar to the Welsh beds.

At Bray Head, county Wicklow, they consist of purplish, red and green shales, slates, and grits. Their thickness has been calculated by Jukes and Du Noyer, who give it at between three and four thousand feet. Fossils:—

<i>Oldhamia antiqua</i>	<i>Arenicolites didymus</i>
<i>O. radiata</i>	<i>A. sparsus</i>
<i>Histioderma hibernica</i>	<i>Haughtonia pœcila</i> .

Similar beds occur in co. Dublin at Howth, and co. Wexford, near Cahore.

The series immediately succeeding this have not been identified in Ireland. The next series containing beds which can be correlated with those in the typical area is the

Lower Bala Series. Beds in County Down have yielded to Mr Swanston all the forms recorded in the list of Glenkiln fossils before given. These and the succeeding beds of this area are continuations of the graptoliferous beds of Dumfriesshire.

Prof. Lapworth records beds of this age as occurring also in counties Wexford, Waterford, and Clare;

<i>Didymograptus</i> sp. (<i>Hisingeri</i>)	<i>Dicellograptus sextans</i>
<i>Climacograptus bicornis</i>	

occur in the three counties, and *Dicranograptus ramosus* in two of them.

Middle Bala Series. The graptolitic shales of County Down have yielded many Hartfell species to Mr Swanston, among others:—

<i>Leptograptus flaccidus</i>	<i>Retiolites fibratus</i>
<i>Dicellograptus caduceus</i>	<i>Diplograptus truncatus</i>
<i>D. moffatensis</i>	<i>D. foliaceus</i>
<i>Dicranograptus Clingani</i>	<i>D. quadrimucronatus</i>
<i>Climacograptus bicornis</i>	<i>D. tricornis.</i>
<i>C. Scharenbergi</i>	

Shallow-water deposits of this age also occur in Ireland being continuations of the Coniston Limestone of the Lake District. On Lambay Island, co. Dublin, the limestone is mentioned by Professors Harkness and Nicholson, as forming a synclinal, and on the main land the same authors mention that below the limestones are beds resembling the Borrodale series. The best known locality for the limestone is in co. Kildare, at the Chair of Kildare, where it has yielded numerous fossils including:—

Phacops Brongniartii	Rhynchonella Portlockiana
Cheirurus cancrurus	Orthis biforata
Sphærexochus calvus	O. monilifera
Lichas bulbiceps	O. insularis
L. hibernicus	Strophomena antiquata
L. laxatus	S. depressa
Cyphoniscus socialis	Mytilus simillimis
Agnostus trinodus	Cyclonema trimarginalis.

Another rich fossil locality is Desertcreight, co. Tyrone, which among other fossils has yielded:—

Phacops Brongniartii	Stygina latifrons
P. (Chasmops) truncato-caudatus	Ampyx rostratus
Encrinurus multisegmentatus	Trinucleus concentricus
Staurocephalus globiceps	T. seticornis
Lichas hibernicus	Orthis fallax
Harpes Doranni	O. porcata
H. Flannagani	Strophomena corrugatella
Calymene senaria	S. rhomboidalis
Remopleurides Colbii	Ambonychia transversa
R. dorso-spinifer	Modiolopsis expansa
Asaphus gigas	Ctenodonta obliqua
Illænus Bowmanni	Trochonema trochiformis
	Patella Saturni.

SILURIAN SYSTEM.

May Hill Series. The beds of County Down have yielded graptolites of well-known Birkhill type to Mr Swanston, e.g.—

Climacograptus normalis	Retiolites perlatus
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Diplograptus folium	M. leptotheca
D. tamariscus	M. Sedgwickii
Cephalograptus cometa	M. spiralis
Monograptus tenuis	M. triangulatus
M. cyphus	Rastrites peregrinus, &c.

and from higher strata, which Prof. Lapworth considers to be probably equivalent to the Gala and Tarannon beds, there have been collected :—

Monograptus galænsis	M. spiralis
M. priodon	M. turriculatus, &c.
M. proteus	

On Lambay Island, and on the mainland in co. Dublin at Portraine, the Coniston Limestone stage is succeeded by coarse conglomerates, with bands of dark shales containing graptolites.

At Kildare, on a hill called Dunmury, to the south-west of the Chain of Kildare, dark coloured rock appears, which Profs. Harkness and Nicholson compare with the Coniston mudstones, also purple and green rocks compared with the Pale Slates.

Salopian Series. In the Dingle promontory, the Ferriter's Cove beds consist of green sands and shales, with bands of red sandstone, about 2,500 feet thick. A list of fossils of Wenlock character, derived from these beds is given by Mr Salter in the explanation to sheet 160 of the *Geological Survey*.

Downtonian Series. The Croaghmarhin beds succeed those last described, and consist of hard, brown calcareous grits about 1,000 feet thick, and occasionally containing *Pentamerus Knightii*. These dip under the Dingle grits, the representatives of the Glengariff grits. "These consist of green and purple grits and shales, which pass up into beds of coarse thick sandstones and grits of greenish and reddish tints" (Kinahan). They are estimated by Jukes and Du Noyer to have a thickness of 10,000 feet. No fossils have been found in them, and they are overlain "unconformably by the Lower Carboniferous sandstones and conglomerates (Old Red Sandstone of the *Geological Survey*) of the central plain."

12. *Occurrence of Silurian Rocks beneath Secondary Group.*

At Ware in Hertfordshire, Wenlock rocks dipping at an angle of 40° to the S.E. were found at a depth of 795 feet from the surface. The rocks consisted of very fossiliferous calcareous shales, and Mr Etheridge among other fossils has determined the following:—

Ischadites Koenigi	Pentamerus galeatus
Periechocrinus moniliformis	P. linguifer
Phacops caudatus	Strophomena euglypha
Meristella tumida	Leptæna transversalis
Cyrtia exporrecta	Mytilus mytilimeris
Spirifera elevata	Euomphalus rugosus
Rhynchonella cuneata	Orthoceras angulatum.
Atrypa reticularis	

§ IV. *Description of the Cambrian and Silurian Rocks of the European Continent.*

1. *Scandinavia.*

Since the work of classification performed by Angelin in this peninsula, the details of the various areas have been worked out by a host of observers of whom I may mention, Profs. Kjerulf, Johnstrup, and Lindstroem, Herr Törnquist, Herr Broegger, Dr Tullberg, but chiefly by the late Dr G. Linnarsson.

CAMBRIAN SYSTEM.

In describing the various areas remote from Britain, it will be more convenient to give an account of the different series under the names by which they are known in the district, and afterwards to give an approximate correlation with the corresponding series of Britain.

Eophyton and Fucoid Sandstones. In Westrogothia Eophyton sandstone and Fucoid sandstone which succeeds it measure together 80 feet; in Scania the collective thickness of the sand-

stones representing these is 900 feet (Lapworth *G. M.* 1881, p. 263). They consist usually of yellow sandstones, bearing evident proofs of deposition in shallow water. Fossils of Eophyton sandstone are Eophyton Linneanum, Obolus? monilifer, Cruziana, &c. and of the Fucoid sandstone, Lingula? favosa, and worm burrows. These sandstones rest unconformably upon pre-Cambrian rocks, and are succeeded conformably by other series. In Norway these rocks are represented by the unfossiliferous Sparagmite formation of Kjerulf. They are the equivalents of the Harlech beds of Britain.

Paradoxides Schists. About 110 feet thick in Scania. They occur also in Westrogothia, and in Norway. Divided into zones by Tullberg (for which see Lapworth, loc cit.). The beds are bituminous black limestones, with interbedded black bituminous shales. Fossils:—

Paradoxides Forchhammeri	Selenopleura brachymetopa
P. Davidis	Arionellus difformis
P. Tessini	Agnostus rex
P. (Olenellus) Kjerulfi	Microdiscus
Liostracus aculeatus	Obolella sagittalis, &c.
Conocoryphe Dalmanni	

They are correlated with the Menevian Series of Britain.

Olenus Schists. Similar in lithological character to the preceding beds, and have a thickness in Scania of about 65 feet. Occur also in Westrogothia and in Norway. Fossils:—

Agnostus pisiformis	Peltura scarabœoides
Olenus gibbosus	Sphærophthalmus alatus
O. truncatus	Eurycare camuricorne
Parabolina spinulosa	Orthis lenticularis, &c.

Dictyonema schists belong to this group, and contain besides Dictyonema, Bryograptus Kjerulfi and Dichograptus tenellus. The beds with which the latter schists are correlated are included in the Tremadoc series of Britain, the main mass of the Olenus schists being the equivalent of the Lingula Flag series.

Ceratopyge Limestone. This limestone occurs in Westro-

gothia, and also in Norway. In Dalecarlia its place is taken by the Obolus grits and conglomerates. It is a black bituminous limestone, similar to those occurring in the Olenus and Paradoxides schists. Fossils:

Ceratopyge forficula	Euloma læve
Conophrys (Shumardia?) pu-	E. ornatum
silla	Erinnys rugosa
Amphion Mathesii	Dikellocephalus dicræura

The limestone contains an intermixture of forms characteristic of so-called primordial and later beds, and it is stated by Törnquist that no break occurs at the base. It is correlated with the Tremadoc series of Britain¹.

Phyllograptus Schists. Orthoceras Limestone. Phyllograptus-bearing shales occur between the Ceratopyge and Orthoceras limestones, as in Westrogothia, and in South Norway. They are greenish or blackish shales only a few feet in thickness, with Phyllograptus, Tetragraptus, Dichograptus, Didymograptus, &c.

The Orthoceras limestone occurs in most parts of Sweden, where Cambrian rocks are found, as also near Christiania, but it differs in thickness in various places, and is probably of slightly different age. For instance in Dalecarlia no Phyllograptus schists underlie it, but Phyllograptus is found in beds intercalated between the limestone. In Westrogothia, &c. as before mentioned it rests upon Phyllograptus schists, whilst at Fogel-

* Since writing this, I have received the description of Stages 2 and 3 of the Norwegian Rocks by Prof. W. C. Brøgger, and he states (p. 10) that there is no sharp boundary either palæontological or petrological between the 'primordial' and succeeding beds. He classifies the Olenus, Ceratopyge and Orthoceras beds as follows:—

Stage 2. Olenus Schists.

8. Asaphus stage.

8 a. a. Shale and limestone with Symphysurus incipiens.

8 a. β. Ceratopyge shale.

8 a. γ. Ceratopyge limestone.

8 b. Phyllograptus shale.

8 c. a. Megalaspis limestone.

8 c. β. Expansus shale.

8 c. γ. Orthoceras limestone.

song in Scania, the limestone which is thin, is succeeded by shales with *Phyllograptus*. It has been by several authors correlated with the Arenig beds of Britain, and its resemblance to the Durness limestone has already been remarked. Fossils:—

<i>Tetragraptus serra</i>	<i>Ampyx nasutus</i>
<i>T. quadribrachiatus</i>	<i>Orthis callactis</i>
<i>Didymograptus affinis?</i>	<i>O. calligramma</i>
<i>D. minutus</i>	<i>Subulites nitens</i>
<i>Phyllograptus densus</i>	<i>Pleurotomaria elliptica</i>
<i>Phacops conicophthalma</i>	<i>Cyrtoceras cornu-venatorium</i>
<i>Niobe frontalis</i>	<i>Discoceras convolvens</i>
<i>Megalaspis limbata</i>	<i>Lituities lituus</i>
<i>Nileus armadillo</i>	<i>Bathmoceras Linnarssoni</i>
<i>Amphion Fischeri</i>	<i>Orthoceras commune</i>
<i>Cheirurus exsul</i>	<i>O. duplex</i>
<i>Illænus crassicauda</i>	<i>O. vaginatum</i>
<i>Asaphus expansus</i>	<i>O. undulato-zonatum</i>
<i>Ptychopyge lata</i>	<i>O. conicum, &c.</i>
<i>Lichas celorrhin</i>	

Middle Graptolite Schists. Above the *Orthoceras* limestone of Scania occur several graptolitic zones, described by Dr Linnarsson.

a. Zone of *Phyllograptus typus*, contains also *Didymograptus*, *Climacograptus Scharenbergi*, &c. It is probable that this zone is represented by the uppermost portion of the *Orthoceras* limestone in other places; whether it is to be referred to the Arenig is at present doubtful.

b. Zone of *Didymograptus geminus*; contains also *Diplograptus foliaceus*, and almost certainly represents the Llanvirn series of Britain.

c. Zone with *Glossograptus Hincksii*, &c.

d. Zone with *Diplograptus mucronatus?* Prof. Lapworth considers to be older than the Glenkiln shales, and he would correlate only the next zone:—

e. Zone with *Climacograptus Scharenbergi* with these shales.

Zones *c*, *d* and *e* are probably all referable to the Lower Bala series.

f. Zone with *Dicranograptus Clingani*.

g. Zone of *Orthis argentea*.

Undoubtedly equivalent to the Lower part of the Hartfell series and are of Middle Bala age.

In other parts of Scandinavia these graptolite shales are replaced mostly by limestones, but as these limestones are usually on somewhat different horizons in different areas, it will hardly be worth while to give a detailed account of each. The Cystidean limestone of Dalecarlia seems to be on a somewhat lower horizon than the *Beyrichia* limestone of Westrogothia, and this again than the *Chasmops* limestone of Christiania.

Trinucleus shales. Found in Dalecarlia, Westrogothia, Ostrogothia, Bornholm, &c. Black and greenish-grey shales, succeeded by red shales. They are the equivalents of the upper portion of the Hartfell shales of Scotland, and of the middle Bala of Wales. Fossils:—

<i>Diplograptus pristis</i>	<i>Trinucleus seticornis</i>
<i>Dicellograptus anceps</i>	<i>Leptæna quinquecostata</i>
<i>D. elegans</i>	<i>Strophomena arachnoidea</i>
<i>Agnostus trinodus</i>	<i>Orthis argentea</i>
<i>Telephus Wegelini</i>	<i>O. nodulosa</i>
<i>Remopleurides radians</i>	<i>Obolella? nitens</i>
<i>Ampyx tetragonus</i>	<i>Nucula</i> sp., &c.
<i>Cybele verrucosa</i>	

Brachiopod Schists (lower part). These beds are found in Westrogothia and Scania, where they consist of two divisions, a lower greenish argillaceous limestone, the zone of *Staurocephalus clavifrons*, containing also:

<i>Sphærocoryphe</i>	<i>Phillipsia parabola</i>
<i>Trinucleus Wahlenbergi</i>	<i>Calymene Blumenbachii</i>
<i>Prætus brevifrons</i>	<i>Agnostus trinodus</i>
<i>Ampyx tetragonus</i>	<i>Holopea concinna</i> , &c.

and an upper stage of blue flaggy shales with:—

Turrilepas	Cybele
Beyrichia	Orthis testudinaria
Trinucleus Wahlenbergi	Holopea concinna, &c.
Phacops eucentra	

These divisions exactly correspond both in lithological and palæontological characters with the Ashgill Shales of the Lake District. In Ostrogothia only the lower division is present, whilst in Dalecarlia the lowest Silurian rocks rest upon the Trinucleus shales, and in Norway in the neighbourhood of Christiania upon the Chasmops limestone.

SILURIAN SYSTEM.

Brachiopod Schists (upper part). *Rastrites Schists*. In Westrogothia the blue shale division of the lower Brachiopod schists is succeeded by calcareous sandstones and limestones with numerous fossils, e.g.:—

Ptychophyllum Linnarssoni	Rhynchonella canaliculata
Plasmoposa conferta	Meristella crassa
Favosites Forbesi	Goniophora carpomorpha
Acidaspis granulata	Climacograptus normalis, &c.
Phacops mucronata	

These pass up into the Rastrites schists, containing true Birkhill graptolites.

In the neighbourhood of Christiania, these beds are represented by coarse calcareous conglomerates with corals, &c., and in Dalecarlia and Scania by thin limestone bands. I have in a paper read before the Geological Society in April 1882, given reasons for supposing that this series rests unconformably upon the beds of the Cambrian System. The Rastrites schists (Lobiferus Schists of Törnquist) are found in Scania, Dalecarlia, Ostrogothia, as well as in Westrogothia; they have been divided into zones by Tullberg, as follows:—

1. Zone with *Diplograptus* n. sp. and *Climacograptus scalaris*. This he places at the top of the Cambrian System, but I believe it should rather be in the Silurian. The lowest zone of the Birkhill shales in Britain does not contain *Mono-graptus*.

2. Zone with *Monograptus cyphus*: contains also *Climacograptus scalaris*, *Dimorphograptus* sp.

3. Zone with *M. gregarius*: also has *M. triangulatus*, *M. fimbriatus*, *Rastrites peregrinus*, &c.

4. Zone with *M. convolutus*: also *M. lobiferus*, *Rastrites peregrinus*, *Cephalograptus folium*.

5. Zone with *Cephalograptus cometa*: also *M. Sedgwickii*, *M. Clingani*, *Diplograptus Hughesii*, &c.

In Norway these beds are represented by shallow-water deposits, the conglomerates before mentioned, being succeeded by olive-grey shales (stage 5β of Kjerulf) with:—

Nidulites favus

P. elegans

Climacograptus normalis

Pentamerus linguifer

Omphyma turbinata

Stricklandinia lens, &c.

Phacops mucronata

this in turn is overlain by limestones crowded with *Pentamerus oblongus*.

The Tarannon shales of Britain are represented in Sweden by passage beds between the *Rastrites* schists and the *Retiolites* schists, found in Scania, and also in Dalecarlia, as at Kallhohn. In Scania, two zones are described by Dr Tullberg:—

1. Zone of *Rastrites maximus*: contains also *M. crispus* and *M. turriculatus*.

2. Zone of *M. runcinatus*: also has *Rastrites Linnæi*, *Monograptus turriculatus*, *M. priodon*, *M. rhynchophorus*, *M. jaculum*, and *Diplograptus palmeus*.

All the Silurian beds hitherto described belong to the May Hill Series.

Cyrtograptus Schists (*Retiolites* schists of Törnquist). Divided into zones by Tullberg from a study of the Scanian deposits:—

1. Zone of *Cyrtograptus Grayæ*: contains also *Monograptus priodon*, *M. cultellus*, *M. nodifer*, *Retiolites Geinitzianus*, &c.

2. Zone of *C. ? spiralis*: also *M. priodon*, *M. Hisingeri*, *M. nodifer*, *Retiolites Geinitzianus*.

3. Zone of *C. Lapworthi*: also *C. pulchellus*, *M. priodon*, *M. Linnarssoni*, *Retiolites Geinitzianus*.

4. Zone of *Monograptus riccartonensis*: also *Monograptus vomerinus*, *M. priodon*.

5. Zone of *Cyrtograptus Murchisoni*: also *M. priodon*, *M. vomerinus*, *Retiolites Geinitzianus*, &c.

6. Zone of *C. rigidus*: also *Monograptus vomerinus*, &c.

7. Zone of *C. Carruthersi*: also *C. Lundgreni*, *Monograptus testis*, *M. vomerinus* and *Cardiola* sp. (*fibrosa*?).

These beds belong to the Salopian series, and are partly represented by the Riccarton beds of Scotland, but contain lower zones than are there found. Beds of the same age occur in Westrogothia, the neighbourhood of Christiania, and in Dalecarlia. In the latter area the Bohemian genus *Arethusina* has been discovered by Törnquist.

The lower portions of the Gothland limestone seem to be the equivalents of these beds, as *Monograptus priodon* and *Retiolites Geinitzianus* are found therein.

Cardiola Schists. These beds, consisting of limestones and interstratified shales, occur in Scania, over 3000 feet in thickness. Fossils:—

<i>Monograptus colonus</i>	<i>M. Nilssoni</i>
<i>M. bohemicus</i>	<i>M. uncinatus</i>
<i>M. dubius</i>	<i>Cardiola interrupta</i>
<i>M. scanicus</i>	<i>Orthocerata</i> , &c.

They also belong to the Salopian series, and there is no doubt about their correlation with the Coldwell beds of the Lake District, for like those beds they succeed immediately the *Cyrtograptus* schists (*Brathay Flags*), and they have the same group of fossils.

The limestones of Gothland, exactly resembling the Wenlock limestone, seem also to be partly contemporaneous with these shales, they were however deposited in shallower water than the *Cardiola* Shales.

In Dalecarlia, the remarkable *Leptæna* limestone seems to be on this horizon, as it appears from reasons I have given (*On the Cambrian and Silurian Rocks of Scandinavia*), to succeed immediately to the *Cyrtograptus* Schists. Its fauna however is most curious; the following are some of the fossils:—

<i>Favosites fibrosus</i>	<i>Harpes Wegelini</i>
<i>Syringophyllum organum</i>	<i>Leptæna Schmidti</i>
<i>Calapoëcia amphigenia</i>	<i>Strophomena luna</i>
<i>Ptychophyllum craigense</i>	<i>S. corrugatella</i>
<i>Cyathophyllum mitratum</i>	<i>Orthis biforata</i>
<i>Halysites escharoides</i>	<i>O. concinna</i>
<i>H. catenularius</i>	<i>Camerella angulosa</i>
<i>Plasmopora conferta</i>	<i>Atrypa altijugata</i>
<i>P. affinis</i>	<i>A. imbricata</i>
<i>Heliolites dubius</i>	<i>Athyris ? Portlockiana</i>
<i>Stylaræa Roëmeri</i>	<i>Meristella crassa</i>
<i>Remopleurides sp.</i>	<i>Ambonychia corrugata</i>
<i>Cybele brevicauda</i>	<i>Flatyostoma harpa</i>
<i>Bronteus laticauda</i>	<i>Eunema carinatum</i>
<i>Illænus Volborthi</i>	<i>E. dalecarlicum</i>
<i>Lichas dalecarlicus</i>	<i>Subulites elongatus ?</i>
<i>Sphærocoryphe granulata</i>	<i>Cyclonema angulosum</i>
<i>Sphærexochus angustifrons</i>	<i>Euomphalus obtusangulus</i>
<i>Cheirurus speciosus</i>	<i>Cyrtoceras longitudinale</i>
<i>Platymetopus planifrons</i>	<i>Orthoceras turris</i>
<i>Isocolus Sjøgreni</i>	<i>O. Wegelini</i>
<i>Encrinurus multisegmentatus</i>	<i>O. leptænarum</i>
<i>Proetus brevifrons</i>	<i>O. funiforme</i>
<i>Deiphon levis</i>	

I have given the above somewhat lengthy list because the palæontological and stratigraphical evidence seems contradictory. According to the above fossils, the Leptæna limestone shews affinity with the May Hill Series, but all the stratigraphical evidence goes towards shewing that the Leptæna limestone succeeds the Cyrtograptus schists.

Bjersjælagerd Limestone. This limestone with its associated shales, Dr. Tullberg correlates with the Aymestry Limestone, but I think it is the equivalent of part of the Salopian Series. Some of the fossils are :—

<i>Labechea conferta</i>	<i>Cyathophyllum dianthus</i>
<i>Cœnites intertextus</i>	<i>Homalonotus rhinotropis</i>
<i>Favosites Forbesi</i>	<i>Calymene Blumenbachii</i>

Phacops Downingiæ	Orthis hybrida
Cytheropsis concinna	Grammysia cingulata
Atrypa reticularis	Platyceras cornutum
Rhynchonella borealis	Igoceras enorme.
R. nucula	

About 400 feet thick.

Kaerrestorp Sandstone, with :—

Chonetes striatella	Grammysia cingulata
Spirifera elevata	G. rotundata.
Atrypa reticularis	

About 800 feet thick. Probably the equivalent of the lower part of the Downtonian series.

Æved Sandstone. Red sandstone of Æved, Ramsosa, &c.

Over 600 feet thick, and contains :—

Beyrichia Buchiana	Lingula minima
B. Kloedeni	Grammysia cingulata var. tri-
Leperditia Angelini	angulata
Encrinurus punctatus	Goniophora cymbæformis?
Tentaculites tenuis	Modiolopsis platyphylla
Atrypa reticularis	Anodontopsis cf. angustifrons
Strophomena ornatella	Dolabra cf. obtusa, &c.
Chonetes striatella	

This is certainly to be correlated with the Downtonian series of Britain.

It is to be noticed that both in Britain and Scandinavia the Downtonian series as defined by Prof. Lapworth consists mainly of sandstones,—the Salopian series mainly of shales with lime-stones.

2. *The Baltic Provinces.*

The Cambrian and Silurian strata of the Baltic Provinces of Russia have been compared by Dr Schmidt with those of Scandinavia and Britain in a paper recently read before the Geological Society (June 21, 1882), and an account of the beds appears in Schmidt's *Revision der Ostbaltischen Silurischen Trilobiten*.

CAMBRIAN SYSTEM.

Stage A.

Blue Clay. The oldest rock, containing *Laminarites antiquissimus* and *Chondrites antiquus*.

Ungulite Grit. About 60 feet thick, with *Obolus Apollinis*.

Dictyonema Schists. About 25 feet thick with *Dictyonema flabelliforme*.

Stage A. probably represents the *Lingula* flag series.

Stage B.

Glaucinite Sandstone, B. 1. A few feet thick, with *Lingulella* cf. *Davisii*, *Obolus Siluricus* and *Siphonotreta*. Correlated with the *Ceratopyge* limestone, and is therefore the equivalent of the *Tremadoc* slate series.

Glaucinite Limestone. Attains a thickness of about 32 feet. In it occur :—

<i>Megalaspis planilimbata</i>	<i>O. parva</i>
<i>M. limbata</i>	<i>Orthisina plana</i>
<i>Orthis calligramma</i> (callactis)	<i>Orthoceras commune</i> , &c.

It corresponds with the *Phyllograptus* shales of Sweden, and with the *Arenig* of Britain.

Vaginatus Limestone, B. 3. This is paralleled with the *Orthoceras* limestone of Sweden. It contains :—

<i>Amphion Fischeri</i>	<i>Cheirurus clavifrons</i>
<i>Asaphus expansus</i>	<i>Rhynchonella nucella</i>
<i>Ptychopyge angustifrons</i>	<i>Orthisina concava</i>
<i>Megalaspis Heros</i>	<i>Maclurea helix</i>
<i>Lichas celorhin</i>	<i>Orthoceras commune</i> , &c.

It is probably in part newer than the *Orthoceras* limestone of Sweden and of *Arenig-Llanvirn* age.

Stage C.

Echinospærites Limestone, C. 1. Attains a thickness of 32 feet. Fossils :—

<i>Echinospærites aurantium</i>	<i>Cheirurus exsul</i>
<i>Glyptosphaerites Leuchtenbergi</i>	<i>Asaphus Weissii</i>
<i>Illænus Schmidtii</i>	<i>Porambonites æquirostris</i>
	<i>Orthisina adscendens</i> , &c.

Kuckers Schist, C. 2. Fossils :—

<i>Glyptocystites penniger</i>	<i>Porambonites teretior</i>
<i>Phacops</i> (<i>Chasmops</i>) <i>Odini</i>	<i>Leptæna sericea</i> var.
<i>Cybele rex</i>	<i>Strophomena imbrex</i> var.
<i>Plænus limbatus</i>	angustior
<i>Asaphus acuminatus</i> , <i>Nieszk</i>	<i>Orthis lynx</i>
<i>Beyrichia complicata</i>	<i>O. calligramma</i> var.
<i>B. strangulata</i>	<i>Maclurea</i>
<i>Siphonotreta unguiculata</i>	<i>Orthoceras vertebrale</i> , &c.

Itfer Schist, C. 3. Hard grey limestone, with argillaceous layers. Fossils :—

<i>Echinosphærites aurantium</i>	<i>Porambonites teretior</i>
<i>Chasmops Odini</i> var. <i>Itferensis</i>	<i>Orthisina Schmidt</i> i, &c.

Stage D.

Jewe Schist. Limestones, concretionary, sometimes dolomitic, with intervening shaly beds. Fossils :—

The lower division, D. 1, has :—

<i>Hemicosmites extraneus</i>	<i>O. Schmidt</i> i
<i>Phacops</i> (<i>Chasmops</i>) <i>bucculenta</i>	<i>O. lynx</i>
<i>Cheirurus pseudohemicranium</i>	<i>Porambonites ventricosa</i>
<i>Orthis rustica</i>	<i>Orthoceras vertebrale</i> , &c.

In the upper division, D. 2, are :—

<i>Phacops</i> (<i>Chasmops</i>) <i>maxima</i>	<i>O. testudinaria</i>
<i>P. bucculenta</i>	<i>Strophomena rugosa</i>
<i>Cybele Kutorgæ</i>	<i>Porambonites ventricosa</i> , &c.
<i>Orthis lynx</i>	

Stage E.

Wesenberg Schist. Yellowish or bluish limestones, with dark argillaceous layers, compose this stage. Fossils :—

<i>Streptelasma</i> sp.	<i>Orthisina Verneuilii</i> var. <i>Wes-</i>
<i>Monticulipora Wesenbergiana</i>	<i>senbergensis</i>
<i>Phacops</i> (<i>Chasmops</i>) <i>Wesenbergensis</i>	<i>Orthis lynx</i>
	<i>O. testudinaria</i>
<i>Cybele brevicauda</i>	<i>Leptæna sericea</i>
<i>Encrinurus Seebachi</i>	<i>Tentaculites anglicus</i>
<i>Porambonites gigas</i> var.	<i>Orthoceras seps</i>
	<i>Gomphoceras conulus</i> , &c.

Dr Schmidt considers this stage to represent the Middle Bala of Britain and the Trenton of North America.

Stage F.

Lyckholm Schist, F. 1. This division consists of thick, white, siliceous limestone, and a grey argillaceous limestone, the whole being about 50 feet thick. Fossils :—

Tetragonis Murchisoni	Lingula quadrata
Halysites labyrinthica var.	Dinobolus Schmidtii
Streptelasma europæum	Porambonites gigas
Syringophyllum organum	Orthis lynx
Phacops (Chasmops) Eichwaldi	O. actoniæ
Sphærexochus angustifrons	O. porcata
Cybele brevicauda	O. insularis
Encrinurus multi-segmentatus	Leptæna Schmidtii
Calymene senaria	Subulites gigas
Harpes Wegelini	Maclurea neritoides
Lichas Dalecarlica	Bellerophon bilobatus
Bronteus laticauda	Lituites antiquissimus, &c.

I think that this also is to be correlated with the Middle Bala beds of Britain. It will be noticed that several species have been recorded as occurring in the Leptæna limestone of Dalecarlia, to which a very different age is assigned by Törnquist. *Borkholm Schist*, F. 2. Consists of white limestone and dark argillaceous beds.

Catenipora labyrinthica var.	Beyrichia sp.
parallela	Stricklandinia sp.
Plasmopora confecta	Atrypa imbricata
Cheirurus (Pseudosphærexochus) conformis	Strophomena expansa
Sphærocoryphe sp.	S. luna
Encrinurus sp.	Leptæna Schmidtii
Lichas margaritifera	Orthis lynx
Proetus ramisulcatus	Murchisonia Nieszkowskii
Illænus Roëmeri	Trochonema cf. umbilicata
Primitia brachynota	Triblydium cf. unguis
	Orthoceras fenestratum, &c.

This group contains a fauna strongly resembling that of the calcareous beds at the base of the Brachiopod Schists of Sweden,

and it occurs about the position of that stage, viz:—above the uppermost representatives of the Middle Bala series. If this be the case, we have in Russia no equivalents of the *Phacops eucentra* shales. It is to be noticed that this group contains fossils which occur also in the *Leptæna* Limestone of Dalecarlia.

SILURIAN SYSTEM.

Stage G.

Joerden Schist, G. 1. This bed is only about 25 feet in thickness. It contains amongst other fossils:—

<i>Heliolites interstincta</i>	<i>Leperditia Schmidtii</i>
<i>Halysites agglomerata</i>	<i>Atrypa imbricata</i>
<i>Calamopora aspersa</i>	<i>Dinobolus Davidsoni</i>
<i>Calymene Blumenbachii</i>	<i>Orthis Davidsoni</i>
<i>Encrinurus punctatus</i>	<i>O. Bouchardi</i>
<i>Bumastus Barriensis</i>	<i>Triblydium</i> .

Borealis Limestone, G. 2. A "Muschelkalk," crowded with *Pentamerus borealis*, about 25 feet in thickness.

Raiküll Schist, G. 3. Not very rich in fossils. It contains:—

<i>Vincularia megastoma</i>	<i>Phacops elegans</i>
<i>Diplograptus estonus</i>	<i>Leperditia Keyserlingi</i>

The whole of Stage G. must be correlated with the May Hill Series of Britain.

Stage H.

Limestone with Pentamerus estonus. This stage contains also:—

<i>Syringopora bifurcata</i>	<i>Leperditia Schmidtii</i>
<i>Halysites distans</i>	<i>Strophomena euglypha</i>
<i>Darwinia speciosa</i>	<i>Atrypa reticularis</i>
<i>Bronteus signatus</i>	<i>Orthoceras canaliculatum</i> , &c.
<i>Bumastus Barriensis</i>	

This may be the equivalent of the uppermost May Hill beds.

Stage I.

Lower Esel Beds. Composed of dolomites and marls about 20 feet in thickness. Fossils:—

<i>Calamopora gothlandica</i>	<i>Rhynchonella Wilsoni</i>
<i>Catenipora distans</i>	<i>Atrypa reticularis</i>
<i>Ptychophyllum patellatum</i>	<i>Strophomena euglypha</i>
<i>Calymene Blumenbachii</i>	<i>Cornulites vagans</i>
<i>Encrinurus punctatus</i>	<i>Tentaculites ornatus</i>
<i>Proetus concinnus</i>	<i>Euomphalus sculptus</i>
<i>Cyphaspis elegantulus</i>	<i>E. funatus</i>
<i>Bumastus Barriensis</i>	<i>Turbo striatus</i>
<i>Beyrichia Klœdeni</i>	<i>Orthoceras annulatum, &c.</i>
<i>Spirifera crispa</i>	

Dr Schmidt parallels this rock with the Wenlock Limestone of England, and the Niagara Limestone of N. America.

Stage K.

Upper Œsel Beds. Grey and yellow sandstones. The following fossils, which are recorded among others, are distinctly Downtonian:—

<i>Proetus latifrons</i>	<i>Rhynchonella nucula</i>
<i>Eurypterus Fischeri</i>	<i>Spirifera elevata</i>
<i>Hemiaspis rugosus</i>	<i>Pterinea retroflexa</i>
<i>Platyschisma helicitates</i>	<i>Murchisonia cingulata</i>
<i>Chonetes striatella</i>	<i>Orthoceras Schmidtii</i>
<i>Retzia Salteri</i>	

It will be noticed, in looking over the preceding fossil lists, that several genera and species make their appearance in the beds of the Baltic provinces, at an earlier horizon than that which characterises their first appearance in Britain; this is probably due to the former area being near the Old pre-Cambrian mainland, a fact borne out by the shallow-water character of the beds.

The Silurian beds are described by Dr Schmidt as being unconformably overlain by the Devonian System.

3. France and Belgium.

We have already seen that in Scotland a ridge of pre-Cambrian rock existed as a higher elevation of the great pre-Cambrian floor upon which the Cambrian rocks were deposited. Such ridges probably existed in several parts of Europe; the ridge in Scotland is supposed by Prof. Hull to be traceable into

Scandinavia, and it may be the same ridge against which the oldest rocks of Dalecarlia were deposited, and which prevented the accumulation of any so-called 'primordial' rocks. These ridges would naturally become land again and again during periods of elevation, and those periods of elevation are marked by the presence of grit beds in areas where deposition was going on. In Britain we have two such grit formations, viz:—the Lingula Flags, and the Garth Grit. As will be pointed out later, a pre-Cambrian ridge in Bohemia was elevated during the period of deposition of the Lingula Flags; in the case of France, where the general floor was higher, there was elevation above the sea during the deposition of all the primordial rocks, and depression took place in this area, about the period of the depression which allowed of the accumulation of deposits above the Garth Grit, viz:—towards the close of the Arenig period. To this time therefore belong the oldest of the deposits in the French area.

The direction of these ridges was probably North East and South West, corresponding with the strike of the latest pre-Cambrian (Pebidian) rocks.

The oldest rocks are found in Brittany, where near St Leonhard des Bois, MM. Triger and de Verneuil describe beds of quartzose sandstone with *Bilobites* and *Lingulæ*. Murchison states that these rocks contain the same fossils as the quartzose rocks of the Stiper-stones, and they are probably of Arenig age for they are succeeded by rocks having an undoubted Llanvirn fauna; these are

The Angers Slates. These consist of black glossy slates, the bedding and cleavage coinciding at Angers, and they have yielded the following fossils among others:—

<i>Calymene Tristani</i>	<i>Phacops socialis</i>
<i>C. Arago</i>	<i>Placoparia Tournemini</i>
<i>Asaphus Guettardi</i>	<i>Cheirurus claviger</i>
<i>Ogygia Desmaresti</i>	<i>Trinucleus Pongerardi</i>
<i>Illænus giganteus</i>	<i>Bellerophon bilobatus</i>
<i>Acidaspis Buchii</i>	

I can find no record of any true Cambrian rocks above these Angers slates in Brittany.

M. Delage gives a similar succession of Cambrian rocks in the department of Ille-et-Vilaine, where sandstone with *Bilobites* is succeeded by Schiste Ardoiser, the equivalent of Angers slate.

In Brittany the Silurian system is represented near Angers. M. Hermite records

Monograptus Becki	D. pristis
M. Sedgwicki ?	Rastrites peregrinus
Diplograptus folium	

as occurring in black shales, the representatives of the Valentian series. At Meignanne, near Angers, the same author records Silurian beds in isolated patches, viz:—slates and limestones with

Monograptus colonus	Orthoceras cf. Bohemicum
Cardiola interrupta	O. cf. dulce.
C. cf. tenuistriata	

These beds represent a high stage in the Salopian series.

A zone intermediate between this and the one with *Rastrites* is recorded by Tromelin and Lebesconte, viz:—shale with Ampelite-nodules containing:—

Monograptus bohemicus	M. priodon
M. Becki	Retiolites Geinitzianus.

This is from Maine and Loire.

We do not therefore get any satisfactory evidence of the relations of the Cambrian and Silurian rocks of France, the Bala series being apparently not represented by any fossiliferous equivalents.

In Belgium, Cambrian rocks are described by M. Malaise as occurring in three massifs, viz:—in Brabant, l'Entre-Sambre-et-Meuse, and near Dour in Hainaut. He gives the following subdivisions in ascending order:—

1. Assize de Blaumont.
2. „ de Tubize.
3. „ d'Orsquercq.
4. „ de Gembloux.

Only the latter is fossiliferous and clearly represents the

Middle Bala series of Britain; it contains among other fossils :—

Phacops conophthalmus	Orthis testudinaria
Calymene incerta	O. vespertilio
Lichas laxatus	O. calligramma
Trinucleus seticornis	O. Actoniæ
Ampyx nudus	O. biforata
Illænus Bowmanni	Trochoceras cornu-arietis.
Cybele verrucosa	

4. *Spain and Portugal.*

CAMBRIAN SYSTEM.

1. Red Limestone of Leon (Spain), contains Paradoxides and Conocoryphe, and is the equivalent of the Menevian Series.

The principal fossils of this red limestone series are :—

Paradoxides pradoanus	C. Sulzeri
Arionellus ceticephalus	C. Ribeiro
Conocoryphe coronatus	Agnostus.

Other representatives of this series also occur in Spain, as in the Montes de Toledo, and near Daroca.

In the Sierra Morena, Montes de Toledo, and Sierras of Aragon, higher Cambrian beds occur.

2. Quartzose sandstones, shales, and black limestones, the shales containing fossils similar to those of the Angers slate, and are therefore of Llanvirn age, though some of the sandstones may be older. In Spain the following fossils occur in these beds :—

Calymene Tristani	Trinucleus Goldfussi
C. Arago	Placoparia Tournemini
Asaphus nobilis	Redonia Deshayesiana
Phacops socialis	Bellerophon bilobatus, &c.
P. Dujardini	

In Portugal, the beds of the Lower Division of Señor Ribeiro in the neighbourhood of Busaco are also of this age. They consist of quartzites, micaceous sandstones, and black shales and limestones with :—

<i>Calymene Tristani</i>	<i>Phacops proævus</i>
<i>C. Arago</i>	<i>Trinucleus Pongerardi</i>
<i>Placoparia Zippei</i>	<i>Redonia Deshayesiana</i>
<i>Illænus giganteus</i>	<i>Ribeiria pholadiformis</i> , &c.

In the same locality these beds are succeeded by the Middle Division of Ribeiro, ochreous argillaceous rocks with :—

<i>Favosites fibrosa</i>	<i>O. Berthoisi</i>
<i>Phacops Dujardini</i>	<i>Porambonites Ribeiro</i>
<i>Orthis testudinaria</i>	<i>Leptæna deltoidea</i> , &c.

SILURIAN SYSTEM.

1. MM. De Verneuil and Barrande record

<i>Monograptus spiralis</i>	<i>M. priodon</i>
<i>M. Halli</i>	<i>M. palmeus</i>

from the strata of the Sierra Morena. This intermixture of Valentian and Salopian forms occurs in the Tarannon shales of other localities.

2. These Valentian beds are not the only representatives of the Silurian system in Spain, for black shales with calcareous nodules occur in the Sierra Morena and other localities containing graptolites along with :—

<i>Cardiola interrupta</i>
<i>Orthoceras Bohemicum</i>
<i>O. styloideum</i> ,

an undoubted Salopian fauna.

In Portugal also, Ribeiro's Upper Division consists of light blue shales, and argillaceous schist with graptolites, *Cardiola interrupta*, and *Orthocerata*.

The Cambrian and Silurian rocks both of France and the Iberian peninsula do not give us an uninterrupted succession, so that we cannot with our present knowledge tell whether or not the Silurian System reposes conformably or unconformably upon the beds of the Cambrian System, the apparent absence of Bala rocks in France seems to point rather to the latter.

5. *Bavaria.*

The beds of Hof in Bavaria are of importance, as we here get, as pointed out by Barrande, an admixture of the so-called

Primordial and second faunas. The following section of this area is given by Murchison, (*Q. J. G. S.* vol. XIX. p. 354):—

- a. Chlorite, and hornblende slate.
- b. Grey, red, and yellow clay slate, micaceous and talcose, above 950 feet.
- c. Crystalline black limestone, 180 feet.
- d. Blackish grey laminated clay slate and lydite, 450 feet.

Judging from the similarity of the description of these beds with that of the highest pre-Cambrian system of Bohemia, these beds are also to be referred to the pre-Cambrian rocks. They are succeeded by:—

- e. Primordial zone, 60 feet.
- f. Siliceous slate and lydite full of graptolites, 270 feet.
- g. Greyish white clay-slate, uppermost being *Nereites* and *Pentamerus* beds, more than 1000 feet.
- h. Cypridina Limestone, 250 feet.
- i. Diabase tuff and breccia.

h and *i* are Devonian.

The series *e* is the one which contains the mixture of 'primordial' and 'second' forms, e.g. M. Barrande states that the 'primordial' *Olenus* and *Conocoryphe* occur along with the 'second' *Calymene* and *Cheirurus*. Besides these *Theca*, and a *Cystidean* are found. This admixture is characteristic of the Tremadoc series, with the exception of *Calymene*, which however is very near the Swedish *Euloma*. Is it not possible that *Euloma* is the genus in the Hof beds? This admixture of faunas at Hof is brought forward in support of the theory of colonies, but it seems rather to tell against it; for if an admixture of primordial and second forms occurs in an abnormal manner, why do not the colonies contain an admixture of second and third forms, instead of (with the exception of that named Zippe) only a group of forms of the third fauna in beds occurring in the middle of the second fauna. As a matter of fact, however, there is nothing abnormal in this Hof fauna, it is simply a passage from one set of beds to another, which we have already seen to be the normal condition of things elsewhere, viz:—in the Tremadoc slates of Britain, and in the *Ceratopyge* Limestone

of Scandinavia, at this horizon. This admixture in fact does nothing more than prove the non-existence of the break which is supposed by many to exist between a primordial and a second fauna. At Hof as elsewhere these supposed separate faunas are found indissolubly knit into one.

6. *Bohemia.*

I have already referred to the elevation of the Bohemian area during a period when shallow water deposits were being formed in Britain, viz. those of the *Lingula* Flag series. It is only after this period that there was continuous deposition all over the Bohemian area, previous to that the beds were only laid down over a small portion of the area, viz. to the north and south of the town of Beroun, which is situated in the centre of the basin.

CAMBRIAN SYSTEM.

The following description gives only a few of the fossils described by Barrande from his different stages.

Stage B. (Upper part).

Conglomerates with pebbles of very great size at base, succeeded by grits and green and red shales. Supposed annelid tracks have been discovered in these by Prof. Fritsch. They repose unconformably upon pre-Cambrian rocks. They may be correlated with the Harlech Series of Britain which they very strongly resemble.

Stage C.

Fine greenish grey and blackish shales, with occasional concretions, and a rich fauna amongst which M. Barrande has found :—

Arionellus ceticephalus
Conocoryphe ornatus
C. striatus
C. Sulzeri
Ellipsocephalus Hoffi
Hydrocephalus carens
Paradoxides bohemicus
P. spinosus

Sao hirsuta
Agnostus integer
A. rex
Orthis Romingeri
Theca prima
Trochocystites bohemicus
Lichenoides priscus.

There is no doubt whatever as to the age of this stage. The fossils are like those of the Menevian beds of Britain, and are some of them specifically identical with those of the Paradoxides beds of Scandinavia.

Stage D.

Band D. d. 1.

a. This structure rests unconformably upon stage C., at other places, where stage C. and the upper part of stage B. are wanting, it rests upon pre-Cambrian rocks. It is made up of conglomerates, with greenish quartzose grits, and contains *Lingula Feistmanteli* in abundance in places. I have elsewhere correlated this with the *Lingula* Flags.

β. Black, green and red pisolitic ironstones with :—

Amphion Lindaueri

Echinosphærites ferrigina

Erinnys Grimmi

Orthis desiderata.

Has a lithological resemblance to the Tremadoc beds of Britain, and like them shews an admixture of 'primordial' and 'second' forms.

Above D. d. 1, *β*, is a series of volcanic rocks, porphyrites and interbedded ashes and agglomerates, which were probably poured out in Arenig times, as no fossils of true Arenig type as defined by Dr Hicks occur in Bohemia; the fossils of the next beds :—

γ, being of Llanvirn type: d. 1 *γ* consists of fine, slightly micaceous, black muddy shales, deposited like those of C. in deep water. Fossils :—

Graptolithus avus (=fragments
of *Didymograptus*?)

Ogygia desiderata

Didymograptus Suessi

Asaphus nobilis

Æglina rediviva

Placoparia Zippei

Barrandeia crassa

Trinucleus Reussi

Calymene Arago

Turrilepas bohemicus

Dionide formosa

Orthis bohémica

Illænus advena

Ribeiria pholadiformis

I. Katzeri

Redonia bohémica

Phacops (Dalmannites) atavus

Conoceras preposterum.

Band D. d. 2.

Hard quartzose grits with some shaly bands, evidently deposited in shallow water. Some of the thin grit bands are ripple-marked and contain annelid tracks. Other fossils are :—

<i>Acidaspis Buchi</i>	<i>Asaphus ingens</i>
<i>Dalmanites socialis</i>	<i>Trinucleus Goldfussi</i>
<i>Illænus Panderi</i>	<i>Turrilepas foliculum</i>
<i>Homalonotus rarus</i>	<i>Orthis redux</i>
<i>Placoparia grandis</i>	<i>Bellerophon bilobatus.</i>

From the resemblance of the fossils to those of the underlying D. d. 1 γ, rather than of the beds above, I should be inclined to compare this band also with the Llanvirn Series.

Band D. d. 3, is composed of fine black muddy shales, deposited in deep water, but interstratified with thin grit bands. Amongst the fossils are :—

<i>Trinucleus Goldfussi</i>	<i>Dalmanites proeva</i>
<i>T. ornatus (= concentricus)</i>	<i>Nucula bohémica</i>
<i>Dionide formosa</i>	<i>Ribeiria Sharpei</i>
<i>Asaphus nobilis</i>	<i>Orthoceras importunum</i>
<i>Æglina rediviva</i>	<i>Climacograptus.</i>

I have before suggested the correlation of this band with the Lower Bala (Llandeilo) series of Britain.

Band D. d. 4, consists of gritty, ferruginous, very micaceous shales, false-bedded and ripple-marked, and with annelid tracks, being evidently deposited in shallow water. A thin band of limestone occurs in one place. Its fauna however connects it with the Middle Bala of Britain. The following list gives only a few of the fossils :—

<i>Trinucleus ornatus</i>	<i>Telephus fractus</i>
<i>Æglina rediviva</i>	<i>Turrilepas fraternus</i>
<i>Calymene incerta</i>	<i>Asterias bohémica</i>
<i>Cheirurus claviger</i>	<i>Orthis elegantula</i>
<i>Homalonotus medius</i>	<i>Leptæna aquila, &c.</i>

Band D. d. 5.

The lower part of this, the Kraluv Dvur shales of Krejczy, consists of deep-water grey and olive green shales, which I have already correlated with the Middle Bala beds of Britain, and

which Linnarsson has shewn to be the equivalent of the Trinucleus shales of Sweden. Some of its fossils are :—

<i>Agnostus tardus</i>	<i>Phillipsia parabola</i>
<i>Æglina rediviva</i>	<i>Sphærexochus latens</i>
<i>Calymene Blumenbachii</i>	<i>Remopleurides radians</i>
<i>Ampyx Portlockii</i>	<i>Strophomena folium</i>
<i>Cheirurus globosus</i>	<i>Leptæna nuntia</i>
<i>Dionide formosa</i>	<i>Ribeiria pholadiformis</i>
<i>Telephus fractus</i>	<i>Diplograptus pristis</i>
<i>Dindymene Frederici-Augusti</i>	<i>Dicellograptus anceps</i> .

The upper part of this band is called the Kosov Grits by Prof. Krejci. I have seen no fossils occurring in the undoubted grits. Its position is that of the Upper Bala Series, and its uppermost beds have been denuded.

SILURIAN SYSTEM.

I have purposely omitted any reference to the Colonies which M. Barrande describes as occurring in D. d. 5, having given reasons elsewhere for supposing that they are due to physical disturbances. The beds of this system repose unconformably upon the beds of the Cambrian System, but the line of junction is rarely seen.

Stage E.

Band E. e. 1.

A conglomerate at the base, succeeded by black shales with calcareous nodules towards the top, passing into thin-bedded limestone at the summit. This band contains four distinct graptolitic zones, the two lower of which are equivalents of the Valentian Series, and the two upper of the Salopian.

Zone 1. Rastrites beds: these are described by me (*Q. J. G. S.* xxxvi. p. 607) as the "Diplograptus-zone."

Some of the fossils are :—

<i>Monograptus cyphus</i>	<i>Rastrites peregrinus</i>
<i>M. lobiferus</i>	<i>Diplograptus folium</i>
<i>M. spinigerus</i>	<i>Climacograptus normalis</i>
<i>M. triangulatus</i>	<i>Discinocaris Brouniana</i> .

This zone is the equivalent of the Birkhill Shales.

Zone 2. *Turriculatus* beds occur at Kuchelbad, Litohlav, &c., and are equivalent to the Gala beds. Fossils:—

<i>Monograptus Becki</i>	<i>Diplograptus palmeus</i>
<i>M. priodon</i>	<i>Rastrites Linnæi</i>
<i>M. turriculatus</i>	

Zone 3. *Cyrtograptus* beds. These are the beds containing the Anthracolite nodules of M. Barrande. Fossils:—

<i>Monograptus priodon</i>	<i>Retiolites Geinitzianus</i>
<i>M. vomerinus</i>	<i>Circulina bohémica</i>
<i>Cyrtograptus Murchisoni</i>	<i>Aptychopsis primus</i>

These beds I previously described as the "priodon-zone." They represent the *Cyrtograptus Murchisoni* beds of Britain and Sweden.

Zone 4. *Colonus* beds. Calcareous black shales weathering yellow with:—

<i>Monograptus colonus</i>	<i>M. Flemingii?</i>
<i>M. testis</i>	<i>Ceratiocaris</i>
<i>M. Roëmeri</i>	<i>Halysites catenularius</i>
<i>M. bohemicus</i>	<i>Cardiola interrupta</i> &c.

The thin limestones at the summit of E. e. 1 contain other fossils, as:—

<i>Ampyx Roualti</i>	<i>Rhynchonella Megæra</i>
<i>Arethusina Konincki</i>	<i>Spirifer trapezoidalis</i> , &c.

I may mention that the zone 2 is also recognisable in certain of the colonies, as the Colony at Hodkoviczek.

Band E. e. 2. Thick-bedded grey crystalline limestone, crowded with fossils, containing calcareous shales in places. Amongst the hundreds of fossils recorded by M. Barrande from this band may be mentioned:—

<i>Ischadites Kœnigi</i>	<i>Ampyx Roualti</i>
<i>Monograptus colonus</i>	<i>Acidaspis mira</i>
<i>M. Roëmeri</i>	<i>Arethusina Konincki</i>
<i>Halysites catenularius</i>	<i>Calymene Blumenbachii</i>
<i>Heliolites confertus</i>	<i>Bronteus planus</i>
<i>Omphyma grandis</i>	<i>Deiphon Forbesi</i>
<i>Ceratiocaris bohemicus</i>	<i>Cheirurus insignis</i>
<i>Turrilepas delicatulus</i>	<i>Harpes venulosus</i>

<i>Sphaerexochus mirus</i>	<i>Spirifer trapezoidalis</i>
<i>Staurocephalus Murchisoni</i>	<i>Cardiola interrupta</i>
<i>Lichas palmata</i>	<i>Lunulicardium bohemicum</i>
<i>Phacops Volborthi</i>	<i>Ecculiomphalus subuloides</i>
<i>Atrypa imbricata</i>	<i>Capulus elegans</i>
<i>Orthis elegantula</i>	<i>Chiton bohemicus</i>
<i>Pentamerus Knightii</i>	<i>Orthoceras bohemicum</i>
<i>P. linguifer</i>	<i>Cyrtoceras sociale</i>
<i>Retzia vesta</i>	<i>Gomphoceras bohemicum</i>
<i>Strophomena trapezoidalis</i>	<i>Ascoceras Murchisoni, &c.</i>
<i>Rhynchonella navicula</i>	

The above list is amply sufficient to indicate the Salopian affinities of this band.

Stage F.

Band F. f. 1.

Black crystalline, thin-bedded limestones, of small thickness, with thin black shales.

<i>Bronteus umbellifer</i>	<i>Tentaculites intermedius</i>
<i>Proetus lepidus</i>	<i>Pilidion bohemicum</i>
<i>Harpes venulosus</i>	<i>Orthoceras originale</i>
<i>Atrypa reticularis</i>	<i>Cyrtoceras pugio, &c.</i>
<i>Spirifer Nerei</i>	

Band F. f. 2.

White or pink crystalline limestones; this band is also thin.

<i>Lichas Haueri</i>	<i>Orthis elegantula</i>
<i>Phacops fecundus, var. major.</i>	<i>O. hybrida</i>
<i>Proetus bohemicus</i>	<i>O. lunata</i>
<i>Harpes venulosus</i>	<i>Pentamerus linguifer</i>
<i>Calymene Blumenbachii</i>	<i>P. galeatus</i>
<i>Bronteus Hawlei</i>	<i>Retzia Barrandei</i>
<i>Sphaerexochus ultimus</i>	<i>Rhynchonella Wilsoni</i>
<i>Atrypa Sappho</i>	<i>Spirifer Nerei</i>
<i>A. marginalis</i>	<i>Strophomena depressa</i>
<i>Chonetes minimus</i>	<i>Bellerophon bohemicus</i>
<i>Leptaena Lewisii</i>	<i>Euomphalus funatus</i>
<i>Merista Herculea</i>	<i>Orthoceras subannulare</i>

Gomphoceras semiclausum	Cheiracanthus bohemicus
Cyrtoceras aequale	Coccosteus primus.
Goniaticites plebeius	

I would correlate Stage F. with the Downtonian Series. The absence of graptolites and the presence of fish bear out this view, as well as the abundance of large Pentameri and the presence of Goniaticites.

Stage G.

Band G. g. 1. Dark grey, compact nodular limestone, with a few shaley bands.

Bronteus Brongniarti	Chonetes hostinensis
Cheirurus gibbus	Avicula grandis
C. Sternbergi	Isocardia potens
Acidaspis Hoernesii	Murchisonia Verneuili
Calymene interjecta	Pilidion bohemicum
Harpes venulosus	Orthoceras pseudo-calamiteum
Phacops fecundus, var. degener	Trochoceras tardum
Ceratiocaris tardus	Goniaticites fecundus
Pterygotus expectatus	Asterolepis bohemicus
Atrypa reticularis	Coccosteus Agassizi
Pentamerus linguifer	Ctenacanthus bohemicus.
Spirifer falco	

Band G. g. 2. Compact, unctuous, mottled shales, with nodules and bands of grey limestone.

Fucoides hostinensis	Chonetes novellus
Ischadites bohémica	Pentamerus linguifer
Petraia bohémica	Spirifer infirmus
Syringopora bohémica	Avicula decipiens
Proetus superstes	Cyrtoceras tenue
Phacops fecundus, var. superstes	Orthoceras annulatum
Cheirurus Sternbergi	Goniaticites fecundus.
Atrypa obovata	

Band G. g. 3. Very like the limestone of g. 1, but of a lighter colour; remarkable for the abundance of Cephalopoda.

Fucoides hostinensis	Phacops fecundus, var. major
Calamopora bohémica.	Chonetes novellus

Lingula cornea	Orthoceras redux
Avicula grandis	O. annulatum
Pilidion fastigiatum	O. dulce
Gomphoceras biconicum	Goniatites bohemicus
Hercoceras mirum	G. fecundus
Phragmoceras Broderipi	Nautilus vetustus.
Trochoceras transiens	

The Stage G. is also to be correlated with the Downtonian series.

Stage H.

Band H. h. 1. Grey non-micaceous shales, ripple-marked and crowded with fucoid remains.

Band H. h. 2, resembles h. 1, but has interstratified grit bands.

Band H. h. 3, is similar to h. 1.

Fossils of H:—

Fucoides hostinensis	Orthoceras equisetum
Lepidodendron sp.	Gyroceras tenue
Phacops fecundus	Goniatites fecundus.
Lingula cornea	

Stage H. may also be correlated with the Downtonian series, but is probably of later age than any rock included in the Silurian system of Wales. It is probably the equivalent of some of the Old Red Sandstone beds, which I think must ultimately be included in the Silurian system.

I may call attention to the resemblance which *Fucoides hostinensis* bears to certain fossils described by Messrs. Binney and Kirkby from the Upper Coal Measures of Scotland (*Q. J. G. S.* xxxviii. p. 245). Like them, the *Fucoides hostinensis* is remarkable for its subrectangular branching. It also occurs with *Lepidodendron*, but this fossil is extremely rare in Stage H.

7. *Thuringia.*

Murchison in his 'Siluria' describes both Lower Silurian (Cambrian) and Upper (true) Silurian rocks in this area, but the difficulty raised by the occurrence of graptolites which he

was accustomed to consider of Llandeilo age, has caused some confusion. The occurrence of *Maclurea* and of a trilobite resembling *Ogygia Buchii* proves the presence of Cambrian rocks. The graptolite-bearing rocks have been shewn by Geinitz and Richter to be of true Silurian age, and representatives of both Valentian and Salopian rocks occur. In the Valentian rocks, besides *Pentamerus oblongus*, *P. globosus*, and *Nereites* are graptolites of Birkhill type, as:—

<i>Monograptus gregarius</i>	<i>Rastrites perigrinus</i>
<i>M. Sedgwicki</i>	<i>Cephalograptus cometa</i>
<i>M. triangulatus</i>	<i>Diplograptus folium</i> , &c.

Whilst Salopian beds are indicated by the occurrence of:—

<i>Monograptus priodon</i>	<i>Cardiola interrupta</i>
<i>M. colonus</i>	<i>Orthoceras bohemicum</i>
<i>Retiolites Geinitzianus</i>	<i>O. styloideum</i> .

The three last-mentioned fossils occur in limestone bands, which, as in the case of Bohemia, succeed the graptoliferous shales.

8. *Sardinia*.

The researches of Meneghini shew the presence of true Silurian rocks in this island. He figures species of *Monograptus* resembling Salopian forms, and the occurrence of *Cardiola interrupta* bears out the conclusion that some at any rate of the Sardinian formations represent the Salopian series.

9. *Podolia*.

M. Malemsey has discovered fossils in limestones, shales, and sandstones, which he correlates with Llandeilo, Caradoc, Wenlock and Ludlow beds. A list of fossils is given in 'Siluria' p. 360, which however does not contain any typical Cambrian forms, whereas the presence of fossils such as:—

<i>Omphyma turbinatum</i>	<i>Proetus concinnus</i>
<i>Calymene Blumenbachii</i>	<i>Sphaerexochus mirus</i>
<i>Iliaenus Barriensis</i>	

seems to point to the Salopian nature of some of the beds.

§ V. *Description of the Cambrian and Silurian Rocks of America.*

In South America, trilobites of 'primordial' type are stated to have been discovered (Barrande, Du Maintien, &c. p. 8), but I have been unable to find any detailed account of the forms. D'Orbigny has also described fossils, as *Cruziana*, graptolites, *Lingula*, *Asaphus*, &c. as occurring in this region, so that a full development of the Cambrian system seems to be found here, but too little is known of the area at present for us to attempt any correlation with series in other countries. The case is different however with the rocks of North America, for there, both in the United States and in Canada, we find a magnificent development of rocks belonging to the Cambrian and Silurian systems, which have been correlated more or less successfully with European deposits.

The table which follows p. 102 is compiled from tables given by Sir W. E. Logan and Dr Sterry Hunt, and shews the principal nomenclatures in use in America, and the correlation of the American series with those of Britain.

1. *Newfoundland.*

The Cambrian and Silurian beds of Newfoundland have been examined by Mr Alexander Murray, and a report of the beds has been given by Sir W. E. Logan.

1. *The Potsdam Sandstone* is divided into three divisions, viz.:—

A. Slates and conglomerates, 2000 feet.

B. Slates and limestone, 1100 feet with

Lingula cf. prima

Paradoxides Bennetti (= *spinosus* ?)

P. (Olenellus) Vermontanus.

C. Limestone with slate 900 feet, contains *Scolithus*.

The Potsdam sandstone therefore seems to represent both the Menevian and *Lingula* Flags of Britain.

2. *Quebec Group.* Limestone, dolomite, serpentine, and

	Britain.	Eastern Canada.	Western Canada.	New York.		Pennsylvania.	Tennessee.
				Lower Helderberg.	Pre-Meridional.		
SILURIAN.	10. Downtonian.	Limestone of Gaspé.	Water Limestone.	Onondaga Salt.	Scalant.		Lower part of Grey Limestone Group.
	9. Salopian.		{ Onondaga Salt Group. Guelph Limestone. Niagara. Clinton.	{ Niagara. Clinton.	{ Sargent.		
	8. Valentian.		Medina Sandstone.	{ Medina Sandstone. Hudson River. Utica.	{ Levant.		
	7. Middle Bala.		{ Hudson River. Utica.	{ Hudson River. Utica.	{ Matinal.		Central limestones and shales, including Stones River and Nashville sub-groups.
CAMBRIAN.	6. Lower Bala (and Llanvirn ?)	wanting ?	{ Trenton. Black River. Birdseye.	{ Trenton. Black River. Birdseye. Chazy.			
	5. Arenig.		{ Chazy. Levis.	{ Chazy.	{ Auroral.		
	4. Tremadoc.	Quebec.	Calceiferous.	Calceiferous.			Magnesian Limestones. Chilhowee Limestones.
	3. Lingula Flag.	Potsdam.	Potsdam.	Potsdam.	Primal.		
	2. Menevian.						
	1. Harlech.						

shales compose this group, and the whole has a thickness of about 5000 feet.

Bathyurus Nero

Piloceras Wortheni

Maclurea Normani

Orthoceras Allumettense.

Murchisonia simulatrix

These rocks seem from the above fossils to belong to the lower part of the Quebec group, the equivalents of the Tremadoc series.

SILURIAN SYSTEM.

The following beds in ascending order are placed in this system by Mr Murray:—

1.	Coarse conglomerates	400 feet.
2.	Sea-green slates	300 "
3.	Grey schist	400 "
4.	Grey arenaceous slates... ..	250 "
5.	Green and black slates with sandstones	650 "
6.	Concretionary slates	250 "
7.	Limestone... ..	7 "
8.	Slates	543 "
		2800

2. Nova Scotia.

The following Silurian rocks are developed in this area, being divided into four groups by Honeyman:—

A. Grey altered argillaceous and arenaceous shales, 200 feet in thickness. These are correlated by Dawson with the May Hill series.

B and B'. Dark ferruginous shales with:—

Monograptus Clintonensis

Grammysia cingulata

The equivalents of the Salopian series.

C. (= Lower Arisaig series of Dawson), more calcareous than the underlying beds:—

Rhynchonella Saffordi

Spirifer rugaecosta, &c.

D. (= Upper Arisaig of Dawson), contains fossils of Lower Helderberg type, and is the equivalent of the Downtonian series.

3. *New Brunswick.*

Mr Matthew has described a group which he terms the St John's group (= Acadian group, Dawson), which is remarkable from having yielded Menevian forms. The whole group is about 4500 feet in thickness, but the Menevian forms occur in a band at the base, only 150 feet in thickness, which succeeds conglomerates, the latter resting unconformably upon crystalline schists. The following fossils occur in this band :—

<i>Agnostus similis</i>	<i>C. Baileyi</i>
<i>Conocoryphe Matthewi</i>	<i>Paradoxides lamellatus</i>
<i>C. Orestes</i>	<i>Microdiscus.</i>
<i>C. Robbii</i>	

The succeeding sandstones and shales contain *Lingula*. Beds of the Silurian system also are found in New Brunswick.

4. *Eastern Canada.*

The Geology of Canada has been well described by Sir W. E. Logan, who treats of the beds of the Eastern and Western parts separately, and in giving here a brief abstract of the nature of the series the same course will be pursued.

CAMBRIAN SYSTEM.

1. *Potsdam Sandstone.* Fossils :—

<i>Kutorgina cingulata</i>	<i>Conocoryphe minor</i>
<i>Orthosina festinata</i>	<i>Bathyrurus parvulus, &c.</i>
<i>Camerella antiquata</i>	

It will be noticed that in America, the beds correlated by American geologists with the *Lingula* Flag series (as the group now under consideration) contain a considerable quantity of mollusca. This is not the case with most of the European deposits of this age, but as I have elsewhere observed, from the abundance of these forms in such rocks as the *Orthoceras* limestone of Sweden, it was to be expected that in some other area they would be found at a lower horizon. In describing the

Potsdam group of the Western part of Canada, I shall have occasion to record the occurrence of Gasteropods and Cephalopods in this group.

2. *Quebec Group*. This group is composed of limestones and shales, and has faunas representing those of the Tremadoc and Arenig rocks of Britain. The limestone at Levis has an undoubted Tremadoc fauna, e.g.

Dikelocephalus planifrons	D. magnificus
D. megalops	Bathyurus quadratus, &c.,
D. Oweni	

whilst in the higher slates occur the celebrated graptolites of this group which have been so successfully compared by several authors with those of the Arenig rocks of Britain. Amongst these are:—

Clonograptus rigidus	Didymograptus bifidus
Loganograptus Logani	Phyllograptus typus
Dichograptus octobrachiatus	P. angustifolius.
Tetragraptus bryonoides	

For a full list the paper by Prof. Lapworth *On the Geological Distribution of the Rhabdophora* may be consulted.

The Hudson River and Trenton groups are apparently wanting in Eastern Canada.

SILURIAN SYSTEM.

Gaspé Limestones. These limestones are about 1200 feet thick, and rest unconformably upon the Quebec group and other rocks; amongst other fossils they contain:—

Phacops	Atrypa reticularis
Bronteus Canadensis	A. laevis
Pterygotus	Avicula naviformis
Pentamerus galeatus	Loxonema Gaspensis, &c.,

and they are correlated by Sir W. Logan with the Lower Helderberg group of New York and the Upper Ludlow rocks of Britain.

5. *Western Canada*.

The beds of this area are stratigraphically continuous with those of New York.

CAMBRIAN SYSTEM.

1. *Potsdam Group.*

This group fills up inequalities in the underlying Laurentian rocks. The lowest part consists of a coarse conglomerate, and this is succeeded by sandstones, the whole being from 300—700 feet in thickness. The following are some of the fossils:—

Scolithus Canadensis	Pleurotomaria
Lingula acuminata	Orthoceras.
Ophileta compacta	

2. *Calciferosus Sandstone.*

This sandstone, which corresponds with the lower part of the Quebec group or with the Tremadoc beds of Britain, is calcareous, and the group contains also granular magnesian limestone, the whole being about 300 feet thick. Fossils:—

Bathyrus Cybele	Trochonema carinata
Lingula Mantelli	Maclurea matutina
Orthosina grandaeva	Piloceras Canadense
Conocardium Blumenbachii	Orthoceras Becki.
Ophileta compacta	

3. *Chazy Formation.*

This, the representative of the upper part of the Quebec group, consists of limestone, associated with sandstones and shales, the whole being about 150 feet thick. Fossils:—

Sphaerexochus parvus	Camerella varians
Harpes antiquatus	C. longirostra
Bathyrus Angelini	Rhynchonella plena
Amphion Canadensis	Lingula Lyelli
Iliaenus globosus	Vanuxemia Montrealensis
Orthos Porcia	Pleurotomaria Calyx, &c.
O. borealis	

4. *Birdseye, Black River and Trenton Formations.*

These consist chiefly of black bituminous limestones, conformable to the lower series, the whole about 600 feet thick. Fossils:—

<i>Illaenus Conradi</i>	<i>Strophomena deltoidea</i>
<i>Bathyrurus extans</i>	<i>Orthis testudinaria</i>
<i>Asaphus megistos</i>	<i>O. subquadrata</i>
<i>A. platycephalus</i>	<i>O. borealis</i>
<i>Phacops callicephalus</i>	<i>O. lynx</i>
<i>P. (Chasmops) Bebryx</i>	<i>Rhynchonella recurvirostria</i>
<i>Bronteus lunatus</i>	<i>Avicula elliptica</i>
<i>Cheirurus pleurexanthemus</i>	<i>Modiolopsis carinata</i>
<i>Calymene Blumenbachii</i>	<i>Ctenodonta astartaeformis</i>
<i>Acidaspis Horani</i>	<i>Cyclonema Halliana</i>
<i>Trinucleus concentricus</i>	<i>Pleurotomaria subconica</i>
<i>Camerella Volborthi</i>	<i>Eunema Erigone</i>
<i>C. Panderi</i>	<i>Murchisonia gracilis</i>
<i>Lingula Eva</i>	<i>Subulites elongatus</i>
<i>Leptaena sericea</i>	

These beds lie between the Chazy group correlated with Arenig rocks, and the Utica slates which contain graptolites of Glenkiln type, they therefore seem to correspond in position with the Llanvirn beds of Britain, but in this case the number of forms of Middle Bala type is remarkable.

5. *Utica Slate and Hudson River Formation.*

This series consists of shales, sandstones, and conglomerates, the whole about 2000 feet thick. Fossils:—

<i>Climacograptus bicornis</i>	<i>Orthis occidentalis</i>
<i>Dicranograptus ramosus</i>	<i>Rhynchonella capax</i>
<i>Triarthrus glaber</i>	<i>Athyris Headi</i>
<i>T. Becki</i>	<i>A. borealis</i>
<i>Proetus Alaricus</i>	<i>Modiolopsis modiolaris</i>
<i>Calymene senaria</i>	<i>Avicula demissa</i>
<i>Cheirurus Icarus</i>	<i>Cyclonema bilix</i>
<i>Asaphus Canadensis</i>	<i>Ascoceras Canadense</i>
<i>Lingula Canadensis</i>	<i>Orthoceras crebriseptum.</i>

Prof. Lapworth records beds containing graptolites of Glenkiln type in the valley of the St Lawrence opposite Albany, where convoluted shales occur, which Mr Whitfield correlates with the Utica slate, and this correlation Prof. Lapworth seems inclined to accept.

In this case, these Utica slates and Hudson River beds represent both Lower and Middle Bala.

SILURIAN SYSTEM.

1. *Medina and Clinton Formations.*

The Medina sandstone is 600 feet thick; it is stratigraphically continuous with that of New York, but the underlying Oneida conglomerate has disappeared.

The sandstones contain only *Arthropycus Harlani* and *Lingula cuneata*.

The Clinton group is only a few feet thick, and consists of shales and limestone with:—

<i>Stenoposa fibrosa</i>	<i>Orthis elegantula</i>
<i>Zaphrentis Stokesii</i>	<i>O. Davidsoni</i>
<i>Bumastus Barriensis</i>	<i>O. porcata</i>
<i>Homalonotus delphinocephalus</i>	<i>Atrypa reticularis</i>
<i>Phacops limulurus</i>	<i>A. hemisphaerica</i>
<i>Strophomena rhomboidalis</i>	<i>Pentamerus oblongus</i>
<i>Athyris naviformis</i>	<i>Rhynchonella cuneata</i> .

This and the Medina sandstone are correlated by Logan with the May Hill Series.

2. *Niagara Formation.*

The lowest limestone placed in this group by Sir W. E. Logan is placed in the underlying Clinton group by the New York geologists.

The Niagara group attains a thickness of 180 feet at Rochester, viz.:—100 feet of very fossiliferous blackish-blue calcareous shale, supporting 80 feet of limestone. Fossils:—

<i>Favosites Gothlandica</i>	<i>Homalonotus delphinocephalus</i>
<i>Heliolites interstincta</i>	<i>Bumastus Barriensis</i>
<i>Halysites catenularius</i>	<i>Leptaena transversalis</i>
<i>Zaphrentis Stokesii</i>	<i>Strophomena rhomboidalis</i>
<i>Eucalyptocrinus decorus</i>	<i>S. pecten</i>
<i>Phacops caudatus</i>	<i>Orthis elegantula</i>
<i>Calymene Blumenbachii</i>	<i>O. hybrida</i>
<i>Encrinurus punctatus</i>	<i>Spirifera crispa</i>

*Atrypa reticularis**Avicula subplana**Rhynchonella cuneata**Acroculia Niagarensis*.

This group has long been correlated with the Wenlock of Britain, a correlation fully supported by the fossils.

3. *Guelph Formation.*

This is apparently wanting in New York. It is composed of 160 feet of dolomites. Fossils:—

*Pentamerus occidentalis**Pleurotomaria solaroides**Megalomus Canadensis**Holopea Guelphensis**Murchisonia macrospira**Bellerophon angustatus*.*Subulites ventricosus*

From what we know of similar formations in Britain, we should probably consider this as a part of the next described group, the association of dolomite with red sandstones and gypsums being familiar.

4. *Onondaga Salt Group.*

This group attains a thickness of 700 feet. It consists of red sandstones, magnesian limestones, gypsum, and sulphate of magnesia. The occurrence of a thick mass of dolomite (the Guelph formation), in the Canadian area at the base of this series, and its absence in New York, reminds one of the occurrence of a mass of fossiliferous magnesian limestone at the base of the New Red Sandstone in Durham, and its absence in the Eden Valley.

I would correlate both Guelph and Onondaga salt groups with the Salopian rocks. Logan places one with the Wenlock, the other with the Ludlow, but they seem to be closely united, so that here again we see that Prof. Lapworth's subdivision of the Silurian system is the natural one.

5. *Lower Helderberg Group.*

This group correlated with the Ludlow beds is divided into five stages in the New York area, but only the lowest of these occurs in Western Canada, viz.:—the Water-lime group. It is from 20 to 45 feet in thickness, consisting of dolomite (water-lime) with *Eurypterus remipes* and *Ceratiocaris*. The occurrence

of this one group in Canada, and its composition, differing from that of the rocks above, makes one feel inclined to place it rather with the Onondaga group than with that of the Lower Helderberg.

6. *New York.*

The series, as described by Hall, in his Palaeontology of New York, are for the most part similar to those of Canada. As the beds are in stratigraphical continuity with those of Western Canada, and rather full fossil lists have been given when describing that area, it is unnecessary to repeat such lists.

CAMBRIAN SYSTEM.

1. *Potsdam Sandstone*, consists of conglomerates, sandstones and shales, with *Scolithus*, *Lingula prima*, and *L. antiqua*.

2. *Calciferosus Sandstone*, contains *Lingula acuminata*, *Maclurea matutina*, *Orthoceras laqueatum*.

3. *Chazy Limestone*. The lower part presents an aggregation of fragments of crinoidal remains, corals, and shells; scarcely any of the fossils ascend into the succeeding series.

4. *Birdseye Limestone*, consists of bluish-grey, or light dove-coloured, fine-grained and compact limestones, in thick layers, with an evenly-bedded structure.

5. *Black River Limestone*, a greyish blue, very compact, and sometimes crystalline limestone.

6. *Trenton Limestone*, for the most part a thin-bedded series, the limestone being of a dark-blue or black colour. The series is shaley at the base.

7. *Utica Slate and Hudson River Group*. Slates and limestones.

SILURIAN SYSTEM.

1. *Oneida Conglomerate* "marks in a most decided and unequivocal manner, the limit between the lower and middle portions of our system. Its wide extent, and in many places its extraordinary development, entitle it to rank as of great importance."

"In the regular ascending order, the Oneida conglomerate

succeeds the Hudson-river group. It sometimes rests on the shales of that group, as in Herkimer County; or succeeds a fine-grained gray sandstone, which may be regarded as terminating the Hudson-river group, and forming a more natural passage into the conglomerate." Hall.

The Oneida conglomerate contains no fossils.

2. *Medina Sandstone*. A nearly homogeneous argillaceous sandstone, almost wholly devoid of fossils, towards its upper termination however it is more purely arenaceous, and contains more fossils.

3. *Clinton Group*. At the base, a shaley deposit occurs, but this is soon succeeded by alternations of sandstone, precisely like the Medina sandstone. In its western extension the Clinton group assimilates in character to the Niagara group, for it assumes a more calcareous character.

4. *Niagara Group*. This is well marked in the neighbourhood of the Niagara Falls, Lockport, &c. and becomes diminished in thickness during its eastward extension, and appears quite subordinate to the Clinton group. It consists, when best developed in Western New York, of a mass of shale, succeeded by one of limestone, the passage between the two taking place by a gradual increase of calcareous matter.

5. *Onondaga Salt Group*, like that of Canada, and the higher drab-coloured layers, are stated by Hall to graduate into the Tentaculite limestone or Water-lime group in places.

6. *Lower Helderberg Group*. I have already stated that only one out of five divisions of this group occurs in Canada, and that it appears to be more nearly allied to the preceding group than this. That division, the Water-lime group, is succeeded by the following:—

a. Pentamerus limestone, a concretionary limestone, with *Pentamerus galeatus*, attaining a thickness of 30 feet.

b. *Delthyris* shaley limestone, with *Spirifera* (*Delthyris*) *macropleura*, is 60—70 feet thick.

c. Encrinital limestone, 25 feet thick.

d. Upper *Pentamerus* limestone, also contains *Pentamerus galeatus*, with *Rhynchonella*.

7. *Vermont, and Massachusetts.* The presence of a Menevian fauna in these areas is noticeable. In Vermont, a red sandstone with dolomite occurs, containing:—

Paradoxides (Olenellus) Thompsoni

P. (O.) Vermontana

Conocoryphe Adamsi.

Whilst in Massachusetts, the Bohemian species, *Paradoxides spinosus* has been found in altered argillaceous sandstone.

8. *Pennsylvania.* This area has been described by the Professors Rogers, and the beds correspond generally with those of New York. The brothers Rogers however rejected the classifications of the British and New York geological surveyors as stated by Dr Hunt, and adopted one of their own, which, as far as the Cambrian and Silurian systems are concerned, is given in the table at the commencement of the description of the North American rocks.

9. *Ohio.* In the *Report of the Geological Survey of Ohio* for 1870, Mr Orton describes the geology of Highland County.

CAMBRIAN SYSTEM.

The Cincinnati or blue limestone group is the only Cambrian rock found in the County, and only the uppermost 50—100 feet of this are found. Ten to twenty feet of red shales overlie the fossiliferous beds at frequent intervals, and when wanting their place is supplied by sandy or shaley limestones.

SILURIAN SYSTEM.

1. The Clinton group succeeds the Cambrian rocks. It is 35—50 feet thick and largely consists of crinoidal limestone. "A bed of limestone conglomerate, several feet in thickness, occurs near the base of the series in the southern part of the county....The pebbles that compose the conglomerate appear to have been derived from the Blue limestone or Cincinnati rocks."

2. Niagara series succeeds the Clinton series. Its total thickness is not less than 275 feet. In ascending order, it consists of the following members:

1. Dayton stone.

2. Niagara shale.

3. West Union or Lower Cliff.
4. Springfield Stone or Blue Cliff.
5. Cedarville gypsiferous limestone.
6. Hillsboro' sandstone.

3. Helderberg Limestone is 15—100 feet in thickness and is succeeded by Huron shales of Devonian age.

10. *Arctic Regions: Grinnell Land, &c.* From the nature of the fossils brought back by the Arctic expedition under Sir George Nares, and described by Mr Etheridge in 1878, it is evident that both Cambrian and Silurian rocks are represented in this area.

CAMBRIAN SYSTEM.

1. Conglomerates, dolomites and limestones with *Maclurea Logani* and *M. magna*, are possibly the equivalents of the Arenig rocks.

2. *Strophomena siluriana* is recorded from this area: in Britain it is Upper Bala.

SILURIAN SYSTEM.

1. *Monograptus convolutus* var. *Coppingeri* was found in fissile shale. It is a Valentian form.

2. The following fossils shew the presence of Salopian beds in the area :—

<i>Favosites gothlandicus</i>	<i>Pentamerus Coppingeri</i>
<i>Halysites catenularius</i>	<i>Atrypa reticularis</i>
<i>Encrinurus laevis</i>	<i>Meristella tumida</i>

§ VI. Conclusion.

In all the areas described in the foregoing pages the Cambrian and Silurian rocks consist of deposits of fine shales, alternating with series of limestones, sandstones, &c. I have attempted to give correlations of the deposits of different areas, by comparing the shale beds with one another, and then correlating the other beds by noting their relations to the shale beds. In doing so, no palaeontological difficulties arise, when considering the shale

beds, but certain abnormal distributions of the limestone and other faunas are noticeable, as in the case of the *Leptaena* limestone of Scandinavia, and the Trenton Group of North America. This may give rise to doubts as to whether the methods I have employed are in reality safe, but in order to test the validity of the method let us apply it to some well-known rocks. The Jurassic Series of Britain consists of a series of clays with alternations of other rocks; these clays then are strictly comparable with the shales of the Cambrian and Silurian rocks. Now we know from actual stratigraphical continuity of the beds that the Lias, Oxford, and Kimmeridge Clays are traceable across Britain, whereas the intermediate limestones and sandstones vary considerably in their lithological characters, their extent, and also their palaeontological characteristics. The clays on the other hand are palaeontologically similar throughout their extent. If these clays are so constant, we need not be surprised to find the Cambrian and Silurian argillaceous beds also widely distributed, and I have already given reasons for supposing that they would be much more widely spread at that period than in subsequent times. These argillaceous beds may be therefore used as means of comparison of the deposits of different areas. I have given reasons for supposing that these beds are in most cases deep-water deposits, and between them occur more or less shallow-water deposits. These shallow-water deposits are often spoken of as being simply due to the rate of deposition being greater than that of depression of the area in which the sediment is settling down, but in many cases it seems to be due to actual upheaval. The sudden change from shale to sandstone would not be brought about by mere silting-up, as the land would still be at the same distance from the area which was receiving deposits, but an actual upheaval of the area would be required to bring the land-margin nearer to the area of deposition. That this was the case with some of the shallow-water deposits of the Cambrian rocks seems evident from the fact that whilst one area received shallow-water instead of deep-water deposits, another area nearer the land was actually raised above the sea-level. The *Lingula* Flag deposits of Britain for instance shew change from deep to shallow water, and part of

the Bohemian area previously submerged was actually upheaved above the sea-level, as shewn by the absence of the *Olenus* fauna, and the occurrence of a conglomerate resting unconformably upon the *Paradoxides*-bearing beds. In this way, we find indications of oscillations of level in Cambrian times, which oscillations were very wide-spread; upward movement is shewn by the *Lingula* Flag deposits, and by the Garth grit, and the greatest upward movement of all is that which took place at the end of the Cambrian period, and it also was wide-spread.

Before considering further the effect of these oscillations it is necessary to say a few words about the physical geography of the European and American areas during the time of the formation of the Cambrian and Silurian deposits. Dr Hicks considers that the American and European areas underwent invasions of organisms, which migrated from some point near the Equator in the middle of what is now the Atlantic Ocean, and this certainly seems to receive support from the recent researches, especially of the distribution of deep-water forms, which for the most part seem to have reached America and Europe simultaneously. This ocean basin would be broader than the Atlantic of the present day, during the greater part of the Cambrian times, and we get some notion of the contour of the land on the European side from the mode of occurrence of the pre-Cambrian rocks, and the time at which the deposition of the Cambrian rocks commenced in different areas. From this it appears that the continental coast-line was indented with bays or gulfs, the intervening promontories running in a general S.W.—N.E.ly direction, in the European area. This ocean basin received the deposits in the Cambrian period, and as at the commencement of that period the land on the European side extended further to the West than it now does, and likewise the land on the American side further to the East, it is in the westerly parts of Europe and the easterly parts of N. America that we should expect to find the earliest deposits, and such is actually the case. In Britain we find a large series of deposits of Harlech age; passing further East, we find a smaller series and shewing shallower-water conditions in Scandinavia. In Bohemia, most of the area

was above water in Harlech times, and the deposits of Harlech and Menevian age in that area seem to have been deposited in a submerged estuary running in a N. and S. direction, for the stages B. and C. are only found in a lenticular mass in the North and South of the basin, so that these deposits run at right angles to the line of strike of the latest Pre-cambrian rocks, and were therefore not deposited in a depression determined by the lateral forces which produced the folding in those rocks. Still further E. in Russia there is no trace of the Harlech beds. On the American continent the earliest beds are found in the extreme Eastern side, as in New Brunswick, Newfoundland, Vermont, and Massachusetts. Even here we do not seem to have any representative of the Harlech beds, so that these are probably buried under the Atlantic Ocean to the East of the United States and Canada.

In the Lingula Flag times the first upward oscillation occurred, and produced the shallow-water deposits of that age in Britain, and elevated the estuary in Bohemia.

These movements were of course of unequal extent in different parts, although so widely spread. Then as in later times, one area underwent depression whilst another underwent elevation, but the curvature of the undulations was small, and the horizontal extent of each undulation large, so that no great amount of folding was produced. This movement in Lingula Flag times does not seem to have been in an upward direction in America, for deposits of Lingula Flag age (Potsdam Sandstone) are the earliest found over a great part of the areas described.

Another upward movement in Britain occurred towards the close of Arenig times, and both before and after this there was great amount of depression, giving rise to the widely-spread deep-water deposits of Arenig and Llanvirn age.

In Bala times there seem to have been minor oscillations, but towards the end of the period, a considerable depression occurred over the European area, giving rise to the Hartfell shales, the Trinucleus shales of Sweden, and the lower part of D. d 5 in Bohemia, &c.

Then at the end of Bala times came that great upward

movement which is marked by shallow-water deposits and usually by unconformities over so large a part of the area which is under consideration. The occurrence of conglomeratic beds and unconformities, in Britain, several parts of the continent of Europe, Canada, New York, Ohio, &c. marks the wide-spread nature of this upheaval, and its importance is further borne out by the palaeontological break which accompanies it. At this horizon it is that we find agreement between the lines drawn by geologists both of Europe and N. America, and at no other horizon is this the case. In trying to separate the Cambrian into two groups the British geologist draws his line at the base of the Arenig, the Russian and Bohemian at the base of the Tremadoc, and some American geologists at the base of the Trenton group, which is on a still higher horizon. Between the Bala and the May Hill series there is a break drawn by universal agreement, for here was the most extensive upheaval.

In the succeeding period there seems to have been a very rapid depression at the commencement in many places, producing the deep-water Birkhill shales, but in other areas shallow-water beds of Valentian age were deposited. Let us here clearly understand what is meant by the Valentian series. The old Lower Llandovery rocks were placed in the Cambrian system, and the Upper Llandovery or May Hill beds in the Silurian system. Subsequently the Lower Llandovery beds were included in the Silurian system, and severed from the Upper Bala series. Prof. Lapworth in calling the Birkhill shales Lower Llandovery, at the same time shews that the great break occurs at the base of that group in Scotland. Consequently the argument that the Birkhill shales are of Upper Bala age, because they have been called Lower Llandovery, and the Lower Llandovery has been once correlated with Upper Bala, is worthless; yet this is the argument employed by the author of the Silurian system of Bohemia in the Fifth Defence of his Colonies. The term Llandovery being the cause of so much confusion, and the term May Hill being one which we cannot apply to the Lower Llandovery beds of the old nomenclature, with any justice, let us adopt Prof. Lapworth's term 'Valentian' for the beds spoken of formerly

as Llandovery, and include under the term, the Tarannon shales, closely connected with the 'Llandovery' rocks.

The oscillations in Silurian times seem to have been less marked than those of the Cambrian period, and the general movement seems to have been one of depression, deposition at the same time gaining on depression. The higher part of the Salopian series is therefore composed of shallower water deposits than the lower part, whilst the Downtonian series is composed of still shallower deposits. This silting-up was accompanied by a sharp fold in the North Welsh and Lake District area towards the close of Silurian times, the result being that deposits ceased forming there before they had ceased in other areas, whilst in Carboniferous times, deposition began in this area at a later period than in other areas. The result of this sharp fold was to convert the Silurian sea-floor in its neighbourhood into a series of confined lakes in which the Lower Old Red Sandstone deposits of Scotland and South Wales were formed. These Lower Old Red Sandstones are shewn by Professor Geikie to be succeeded by the Upper Old Red, which rest upon them with great discordance, and pass conformably into the Carboniferous beds. Prof. Geikie also considers the Lower Old Red rocks of Scotland to be the equivalents of the Glengariff beds of Ireland, which Prof. Hull considers to be Silurian, and correlates them with the Foreland Grits and Slates of South Devon.

Prof. Hull considers the Middle Devonian beds of Devonshire to be unrepresented in the Irish area, they are however physically the base of the Carboniferous rocks, deposited in the first part of the Carboniferous area which underwent submergence, just as the Harlech beds are only found in a few areas, whilst the Cambrian deposits of other areas did not commence to be formed until Menevian or later times. Eventually then these Lower Old Red Sandstones and their equivalents must be considered as a subdivision of the Silurian rocks, whether they are included in the Downtonian series or form a separate series. At the top of these beds is the true break, and the true summit of the Silurian system, although that system, as founded by its author, was without a true summit, just as it was without a true base. As so defined the Silurian system is worthy to rank alongside

of the older Cambrian system, and there is no need to split these up into a threefold series, for the sake of recognising the occurrence of three faunas.

Every year as our knowledge of the older rocks increases, we find an increasing number of forms common to the so-called primordial and second faunas, and so various were the forms of different series in the earlier Cambrian beds, that geologists cannot agree as to where to draw the line between the primordial and the second faunas. Is it to be where *Paradoxides* (the genus which is particularly dear to the supporter of the primordial fauna) disappears, viz. at the top of the Menevian, for this is where Barrande practically draws it in Bohemia, if *D. d 1 γ* represents, as I consider, part of the *Lingula* Flag series? Or is it to be at the base of the Tremadoc, where *Olenus* becomes rare, and is represented only by subgenera, and where new forms as *Angelina*, *Ceratopyge*, *Cheirurus*, *Amphion* &c. appear? This is where M. Barrande draws it in his paper on the maintenance of the Silurian nomenclature of Murchison, and where Schmidt draws it in the Russian provinces? Or is it to be drawn at the base of the Arenig rocks, as is done by British geologists? Or lastly, shall we draw it at a still higher horizon where one of "the grandest zoological breaks in the whole Lower Palaeozoic series" occurs, viz.—"between the Canadian and Trentonian of North America." Wherever we draw it, it will be of local significance only, and a proof of the extremely small value of palaeontological evidence used by itself in the classification of rock-groups. Surely the best thing to be done is not to draw it at all. Prof. Lapworth says:—"We shall best promote the interest of the man whose memory we venerate, by modestly claiming for him as much, and no more, than truth and geological convenience will allow."

In upholding the classification of Prof. Sedgwick in the foregoing pages I have tried to do this, and I see neither truth nor geological convenience in adopting any other classification than that which includes the rocks from the base of the Harlech to the top of the Bala series in the Cambrian system, and the rocks from the base of the Valentian to the top of the Down-tonian series in the Silurian system.

The table appended gives the correlation of the rocks in those areas where the sequence has been more fully studied. The beds of France, Spain &c. are not inserted, as there seems to be some doubt as to whether certain beds should be included in the Bala series or not. At the same time by consulting the text the relationship of the deposits of those areas to the deposits of the areas which are included in this table may be readily found.

Britain.	Scandinavia.	Russia.	Bohemia.	N. America.
Downtonian.	{ Sandstones of Ramsøse and Kaerrstorp.	K.	H. G. F.	Lower Helderberg.
Salopian.	{ Gothland limestone. Cardiola beds, Leptaena limestone. Cyrtograptus shales.	I.	E. 2. Part of E. 1.	Onondaga salt group. Niagara.
Valentian.	Rastrites shales. Brachiopod beds (upper).	H? G.	Part of E. 1.	Clinton. Medina. Oneida.
Bala.	Brachiopod beds (lower). Trinucleus shales. Chasmops limestones. Middle Graptolite shales.	F. E. D.	D. 5. D. 4. D. 3.	Hudson River. Utica slate.
Llanvirn.	Murchisoni—shales of Scania Orthoceras limestone in part.	C? B _s in part?	D. 2. D 1 γ.	{ Trenton. Black River. Birdseye.
Arenig.	Orthoceras limestone (part). Phyllograptus shales.	B _s in part. B _s .	Volcanic beds.	Chazy.
Tremadoc.	Ceratopyge beds.	B ₁ .	D 1 β.	Calceiferous.
Lingula Flag.	Olenus schista.	A?	D 1 α.	Potsdam.
Menevian.	Paradoxides schista.		C.	Braintree and St John.
Harlech.	Eophyton and Fucoid sandstones.		B in part.	

APPENDIX.

THE following tabular lists contain only the names of those fossils which are mentioned in the foregoing pages. The first list is devoted to the fossils of the British Isles, and the second to those of the foreign strata; this I considered a better arrangement than would have been the inclusion of all the fossils in one list, for many of the foreign beds are, as previously mentioned, to be correlated only approximately with the British series. It must be distinctly understood that the species are generally recorded as occurring in those beds in which they are most abundant, but that in many cases the vertical ranges of the genera and species are by no means indicated by the tables.

The fossils of the Leptaena limestone of Dalecarlia are placed in the Wenlock column: this correlation however is doubtful (ante p. 80). Prof. F. Schmidt (*Q. J. G. S.* xxxviii. p. 524) correlates this limestone with his stage F. of the Baltic provinces of Russia,—a stage corresponding with the higher Bala beds of Britain.

TABLE I. BRITISH FOSSILS.

[illegible]

	Harlech	Menevian	Langula Fl.	Tremadoc	Arenig and Llanvirn	Lower Bala	Middle Bala	Upper Bala	May Hill	Salopian	Downtonian
<i>Sub-kingdom. COELENTERATA.</i>											
<i>Class. HYDROZOA.</i>											
Amphigraptus divergens, Hall	...	...	...	*	...	...	*				
Bryograptus Callavei, Lapw.	...	...	...	...	...	...	...				
Callograptus radiatus, Hopk.	...	...	...	...	...	...	...				
elegans, Hall.	...	...	...	...	...	...	...				
Calyptragraptus? plumosus, Lapw.	...	...	...	...	...	...	...		*		
Cephalograptus cometa, Gein.	...	...	...	...	...	...	...	...	*		
Climacograptus antennarius, Hall	...	...	...	...	...	...	...	...	*		
teretiunculus, His.	...	...	...	...	...	...	...	...	*		
bicornis, Hall	...	...	...	...	...	*	*		*		
confertus, Lapw.	...	...	...	...	...	*	*		*		
coelatus, Lapw.	...	...	...	...	...	*	*		*		
normalis, Lapw.	...	...	...	...	...	...	...	...	*		
perexcavatus, Lapw.	...	...	...	...	...	*	...	...	*		
rectangularis, McCoy	...	...	...	...	...	...	...	...	*		
Scharenbergi, Lapw.	...	...	...	...	...	*	*	...	*		
tubuliferus, Lapw.	...	...	...	...	...	*	*		*		
Clathrograptus cuneiformis, Lapw.	...	...	...	...	...	*	...		*		
Clonograptus	...	...	...	*	...	...	...		*		
Coenograptus gracilis, Hall	...	...	...	...	...	*	...		*		
Cyrtograptus Grayae, Lapw.	...	...	...	...	...	...	...	...	*	*	
Carruthersi, Lapw.	...	...	...	...	...	...	...	...	*	*	
Murchisoni, Carr.	...	...	...	...	...	...	...	...	*	*	
Dendrograptus furcatula, Salt.	...	...	...	...	*	...	...	...	*		
flexuosus, Hall	...	...	...	...	*	...	...	...	*		
Dicellograptus anceps, Nich.	...	...	...	...	...	...	*		*		
caduceus, Lapw.	...	...	...	...	...	...	*		*		
elegans, Carr.	...	...	...	...	...	...	*		*		
Forchhammeri, Gein.	...	...	...	...	...	...	*		*		
moffatensis, Carr.	...	...	...	...	...	*	*		*		
sextans, Hall	...	...	...	...	...	*	*		*		
Dichograptus octobrachiatus, Hall	...	...	...	...	*	...	...		*		
Dicranograptus ramosus, Hall	...	...	...	...	*	*	*		*		
Olingani, Carr.	...	...	...	...	...	*	*		*		
formosus, Hopk.	...	...	...	...	...	*	...		*		
Nicholsoni, Hopk.	...	...	...	...	...	...	*		*		
Dictyonema delicatulum, Lapw.	...	...	...	...	...	...	...	...	*		
Homfrayi, Hopk.	...	...	...	...	*	...	...	...	*		
sociale, Salt.	...	...	*	*	...	...	...	...	*		
venustum, Lapw.	...	...	...	...	...	...	...	...	*		
retiformis, Hall	...	...	...	...	...	...	...	...	*	*	
Diplograptus acuminatus, Nich.	...	...	...	...	...	...	...	...	*		
angustifolius, Hall	...	...	...	...	...	*	...	...	*		
confertus, Lapw.	...	...	...	...	...	...	...	...	*		
dentatus, Brong.	...	...	...	...	*	*	...	...	*		
euglyphus, Lapw.	...	...	...	...	*	*	...	...	*		
foliaceus, Murch.	...	...	...	...	*	*	*	...	*		
folium, His.	...	...	...	...	...	...	...	...	*		
Hughesii, Nich.	...	...	...	...	...	...	...	...	*		
modestus, Lapw.	...	...	...	...	...	...	...	...	*		
mucronatus, Hall	...	...	...	*	...	...	...	...	*		

	Harlech	Menevian	Lingula Fl.	Tremadoc	Arenig and Llanvirn	Lower Bala	Middle Bala	Upper Bala	May Hill	Salopian	Downtonian
<i>Monograptus spiralis</i> , Gein.	...	...	...	...	...	...	...	...	**		
— <i>tenuis</i> , Portl.	...	...	...	...	...	...	...	...	**		
— <i>turriculatus</i> , Barr.	...	...	...	...	...	...	...	...	**		
— <i>vomerinus</i> , Nich.	...	...	...	...	...	...	...	...	**	*	
<i>Odontocaulis Keepingi</i> , Lapw.	...	...	...	...	...	...	...	...	**		
<i>Phyllograptus angustifolius</i> , Hall	...	...	...	...	*	...	...	...	**		
— <i>Anna</i> , Hall	...	...	...	...	*	...	...	...	**		
— <i>stella</i> , Hopk.	...	...	...	...	*	...	...	...	**		
— <i>typus</i> , Hall	...	...	...	...	*	...	...	...	**		
<i>Pleurograptus linearis</i> , Carr.	...	...	...	...	...	...	*	...	**		
<i>Protovirgularia dichotoma</i> , McCoy	...	...	...	...	...	...	...	...	**		
<i>Rastrites fugax</i> , Barr.	...	...	...	...	...	...	...	...	**		
— <i>maximus</i> , Carr.	...	...	...	...	...	...	...	...	**		
— <i>peregrinus</i> , Barr.	...	...	...	...	...	...	...	...	**		
— <i>triangulatus</i> , Harkn.	...	...	...	...	...	...	...	...	**		
<i>Retiolites fibratus</i> , Lapw.	...	...	...	...	...	...	*	...	**		
— <i>Geinitzianus</i> , Barr.	...	...	...	...	...	...	...	...	**	*	
— <i>perlatus</i> , Nich.	...	...	...	...	...	...	...	...	**		
<i>Rhizograptus? digitatus</i> , Lapw.	...	...	...	...	...	...	...	...	**		
<i>Tetragraptus bryonoides</i> , Hall	...	...	...	...	*	...	...	...	**		
— <i>crucifer</i> , Hall	...	...	...	...	*	...	...	...	**		
— <i>Headi</i> , Hall	...	...	...	...	*	...	...	...	**		
— <i>quadribrachiatus</i> , Hall	...	...	...	...	*	...	...	...	**		
— <i>serra</i> , Brong.	...	...	...	...	*	...	...	...	**		
<i>Trigonograptus lanceolatus</i> , Nich.	...	...	...	...	*	...	...	...	**		
— <i>ensiformis</i> , Hall	...	...	...	...	*	...	...	...	**		
<i>Class. ACTINOZOA.</i>											
<i>Choetetes petropolitana</i> , Pander	...	...	...	...	...	...	*	...	**		
<i>Favosites alveolaris</i> , Goldf.	...	...	...	...	...	...	...	...	**		
— <i>fibrosa</i> , Goldf.	...	...	...	...	...	...	...	*	**	*	
— <i>Gothlandica</i> , Linn.	...	...	...	...	...	...	...	...	**		
<i>Halysites catenularius</i> , Linn.	...	...	...	...	...	...	...	...	**		
<i>Heliolites interstincta</i> , Wahl.	...	...	...	...	...	...	*	...	**		
— <i>megastoma</i> , McCoy	...	...	...	...	...	...	...	...	**		
— <i>petalliformis</i> , Lonsd.	...	...	...	...	...	...	...	...	**		
— <i>tubulata</i> , Lonsd.	...	...	...	...	...	...	...	...	**		
<i>Lindstroemia subduplicata</i> , McCoy	...	...	...	...	...	...	...	...	**		
<i>Nebulipora lens</i> , McCoy	...	...	...	...	...	...	...	*	**		
<i>Omphyra turbinata</i> , Linn.	...	...	...	...	...	...	...	...	**	*	
<i>Petraia bina</i> , Lonsd.	...	...	...	...	...	...	...	...	**		
— <i>elongata</i> , Phill.	...	...	...	...	...	...	...	...	**		
— <i>rugosa</i> , Phill.	...	...	...	...	...	...	...	...	**		
— <i>uniserialis</i> , McCoy	...	...	...	...	...	...	...	...	**		
<i>Phyllopora Hisingeri</i> , McCoy	...	...	...	...	...	...	...	...	**		
<i>Streptelasma? aequiscalcatum</i> , McCoy	...	...	...	...	...	...	*	...	**		
<i>Syringophyllum organum</i> , Linn.	...	...	...	...	...	...	*	...	**		
<i>Sub-kingdom. ANNULOIDA.</i>											
<i>Class. ECHINODERMATA.</i>											
<i>Actinocrinus pulcher</i> , Salt.	...	...	...	...	...	...	...	...	...	*	
<i>Caryocystites Davisii</i> , McCoy	...	...	...	...	...	...	...	*	...		

	Harlech	Menerlan	Lingula Fl.	Tremadoc	Arenig and Llanvirn	Lower Bala	Middle Bala	Upper Bala	May Hill	Salopian	Downtonian
<i>Crotalocrinus rugosus</i> , Mill.	..	..	..	..	..	..	..	..	..	*	
<i>Echinospaerites balticus</i> , Eichw.	..	..	..	..	..	..	*	..	..	*	
<i>granatum</i> , Wahl.	..	..	..	..	..	..	*	..	..	*	
<i>Glyptocrinus basalis</i> , McCoy	..	..	..	..	..	..	*	..	..		
<i>Ichthyocrinus MacCoyanus</i> , Salt.	..	..	..	..	..	..	..	..	..	..	*
<i>Palaeaster hirudo</i> , Forbes	..	..	..	..	..	..	..	..	..	..	*
<i>obtusius</i> , Forbes	..	..	..	..	..	..	*	..	..	..	*
<i>Ruthveni</i> , Forbes	..	..	..	..	..	..	..	..	..	..	*
<i>Palasterina primaeva</i> , Forbes	..	..	..	..	..	..	..	..	..	..	*
<i>Periechocrinus moniliformis</i> , Mill.	..	..	..	..	..	..	..	..	..	*	
<i>Pleurocystites Rugeri</i> , Salt. ?	..	..	..	..	..	..	..	..	*	..	
<i>Protaster Miltoni</i> , Salt.	..	..	..	..	..	..	..	..	..	*	
<i>Pseudocrinites quadrfasciatus</i> , Pearce	..	..	..	..	..	..	..	..	..	*	
<i>Sphaeronites stelluliferus</i> , Salt.	..	..	..	..	..	..	*	..	..	*	
<i>Taxocrinus Orbigny</i> , McCoy	..	..	..	..	..	..	..	..	..	..	*
<i>tesseracontadactylus</i> , His.	..	..	..	..	..	..	..	..	..	*	
<i>Class. ANNELIDA (and various tracks).</i>											
<i>Arenicolites didymus</i> , Salt.	*										
<i>sparsus</i> , Salt.	*										
<i>Crossopodia scotica</i> , McCoy	..	..	..	..	..	..	..	..	*		
<i>Cruziana semiplicata</i> , Salt.	..	..	*								
<i>Haughtonia poecila</i> , Kinahan	*										
<i>Histioderma hibernica</i> , Kinahan	*										
<i>Myrianites MacLeayi</i> , Murch.	..	..	..	..	..	..	..	..	*		
<i>tenuis</i> , McCoy	..	..	..	..	..	..	..	..	*		
<i>Nereites Sedgwicki</i> , Murch.	..	..	..	..	..	..	..	..	*		
<i>Palaeochorda major</i> , McCoy	..	..	..	..	*				*		
<i>Scolecoderma antiquissima</i> , Salt.	..	..	*						*		
<i>Serpulites longissimus</i> , Salt.	..	..	..	..	..	..	..	..	..	..	*
<i>Tentaculites anglicus</i> , Salt.	..	..	..	..	..	..	..	..	*		
<i>ornatus</i> , Sow.	..	..	..	..	..	..	..	..	..	*	
<i>Sub-kingdom. ANNULOSA.</i>											
<i>Class. CRUSTACEA.</i>											
<i>Acidaspis Brightii</i> , Murch.	..	..	..	..	..	..	..	..	*	*	
<i>crenatus</i> , Emmer.	..	..	..	..	..	..	..	..	..	*	
<i>granulatus</i> , Ang.	..	..	..	..	..	..	..	..	*	*	
<i>Hughesii</i> , Salt.	..	..	..	..	..	..	..	..	..	*	
<i>Ægina binodosa</i> , Salt.	..	..	..	..	..	..	..	..	..	..	
<i>caliginosa</i> , Salt.	..	..	..	..	*						
<i>grandis</i> , Salt.	..	..	..	..	*						
<i>Hughesii</i> , Hicks	..	..	..	..	*						
<i>major</i> , Salt.	..	..	..	..	*						
<i>obtusicaudata</i> , Hicks	..	..	..	..	*						
<i>Agnostus hirundo</i> , Salt.	..	..	..	..	..						
<i>MacCoyi</i> , Salt.	..	..	..	..	..	*					
<i>Morei</i> , Salt.	..	..	..	..	*						
<i>princeps</i> , Salt.	..	*	*	..	..						
<i>reticulatus</i> , Ang.	..	*	..	..	..						
<i>trisectus</i> , Salt.	..	..	*	..	..						
<i>trinodus</i> , Salt.	..	..	..	..	..		*				

	Harlech	Meneyian	Lingula Fl.	Tremadoc	Arenig and Llanvira	Lower Bala	Middle Bala	Upper Bala	May Hill	Salopian	Downtonian
<i>Ampyx nudus</i> , Murch.	...	...	...	...	...	*					
— <i>rostratus</i> , Sars	...	...	...	...	...	*	*				
— <i>Roualtii</i> , Barr.	...	...	...	...	...	*	...	...	?		
— <i>Salteri</i> , Hicks	...	...	...	...	*	*	...	...			
— <i>tumidus</i> , Forbes	...	...	...	...	*	*	*				
<i>Angelina</i> Sedgwicki, Salt.	...	...	...	*	*						
<i>Anopolenus</i> Henrici, Salt.	...	*	...	*	*						
<i>Arionellus</i> longicephalus, Hicks	...	*	...	*	*						
<i>Asaphus</i> affinis, McCoy	...	...	...	*							
— <i>gigas</i> , De Kay	...	...	...	*			*				
— <i>Homfrayi</i> , Salt.	...	...	...	*	*		*				
— <i>Powisii</i> , Murch.	...	...	...	*	*	...	*				
— <i>tyrannus</i> , Murch.	...	...	...	*	*	*	*				
<i>Barrandea</i> Cordai, McCoy	...	...	...	*	*	*	*				
— <i>Homfrayi</i> , Hicks	...	...	...	*	*	*	*				
<i>Beyrichia</i> complicata, Salt.	...	...	...	*	*	*	*				
— <i>Kloedeni</i> , McCoy	...	...	...	*	*	*	*	...	...	*	*
— <i>stragulata</i> , Salt.	...	...	...	*	*	*	*	...	...	*	*
<i>Calymene</i> Blumenbachii, Brong.	...	...	...	*	*	*	*	...	*	*	*
— <i>duplicata</i> , Murch.	...	...	...	*	*	*	*	...	*	*	*
— <i>brevicapitata</i> , Portl.	...	...	...	*	*	*	*	...	*	*	*
— <i>parvifrons</i> , Salt.	...	...	...	*	*	*	*	...	*	*	*
— <i>parvifrons</i> var. <i>Murchisoni</i> , Salt.	...	...	...	*	*	*	*	...	*	*	*
— <i>senaria</i> , Conrad	...	...	...	*	*	*	*	...	*	*	*
— <i>Tristani</i> , Brong.	...	...	...	*	*	*	*	...	*	*	*
— <i>tuberculosa</i> , Salt.	...	...	...	*	*	*	*	...	*	*	*
<i>Caryocaris</i> Wrightii, Salt.	...	...	...	*	*	*	*	...	*	*	*
— <i>Marrii</i> , Hicks	...	...	...	*	*	*	*	...	*	*	*
<i>Ceratiocaris</i> inornatus, McCoy	...	...	...	*	*	*	*	...	*	*	*
— <i>Murchisoni</i> , McCoy	...	...	...	*	*	*	*	...	*	*	*
— <i>papilio</i> , Salt.	...	...	...	*	*	*	*	...	*	*	*
— <i>robustus</i> , Salt.	...	...	...	*	*	*	*	...	*	*	*
— <i>solenoides</i> , McCoy	...	...	...	*	*	*	*	...	*	*	*
— <i>stygius</i> , Salt.	...	...	...	*	*	*	*	...	*	*	*
— ? <i>latus</i> , Salt.	...	...	...	*	*	*	*	...	*	*	*
— ? <i>insperatus</i> , Salt.	...	...	...	*	*	*	*	...	*	*	*
<i>Cheirus</i> bimucronatus, Murch.	...	...	...	*	*	*	*	...	*	*	*
— <i>cancrurus</i> , Salt.	...	...	...	*	*	*	*	...	*	*	*
— <i>Frederici</i> , Salt.	...	...	...	*	*	*	*	...	*	*	*
— <i>juvenis</i> , Salt.	...	...	...	*	*	*	*	...	*	*	*
— <i>Sedgwickii</i> , McCoy	...	...	...	*	*	*	*	...	*	*	*
<i>Conocoryphe</i> depressa, Salt.	...	...	...	*	*	*	*	...	*	*	*
— <i>solvensis</i> , Hicks	*	...	...	*	*	*	*	...	*	*	*
— <i>variolaris</i> , Salt.	...	*	...	*	*	*	*	...	*	*	*
— <i>verisimilis</i> , Salt.	...	...	...	*	*	*	*	...	*	*	*
<i>Conocoryphe</i> ? (<i>Acerocare</i>) <i>ecorne</i> , Ang.	...	...	?	*	*	*	*	...	*	*	*
<i>Conophrys</i> salopiensis, Call.	...	...	...	*	*	*	*	...	*	*	*
<i>Ctenopyge</i> (<i>Olenus</i>) <i>flagellifera</i> , Ang.	...	...	...	*	*	*	*	...	*	*	*
<i>Cybele</i> <i>Loveni</i> , Linnarsson	...	...	...	*	*	*	*	...	*	*	*
— <i>ovata</i> , Ether.	...	...	...	*	*	*	*	...	*	*	*
— <i>rugosa</i> , Portl.	...	...	...	*	*	*	*	...	*	*	*
<i>Cyphaspis</i> megalops, McCoy	...	...	...	*	*	*	*	...	*	*	*

	Harlech	Menevian	Lingula Fl.	Tremadoc	Arenig and Llanvirn	Lower Bala	Middle Bala	Upper Bala	May Hill	Salopian	Downtonian
<i>Cyphoniscus socialis</i> , Salt.	...	...	...	...	...	...	*				
<i>Cythere umbonata</i> , McCoy	...	...	...	...	...	...	*				
<i>Dictyocaris Slimoni</i> , Salt.	...	...	...	...	...	...	*				
<i>Dikellocephalus celticus</i> , Salt.	...	...	*		...	...					*
— <i>furca</i> , Salt.	...	...	...	*	...	...					
<i>Dindymene Cordai</i> , Nich. and Eth.	...	...	...	...	...	...	*				
<i>Dionide atra</i> , Salt.	...	...	...	...	*	...					
<i>Discinocaris Browniana</i> , Woodw.	...	...	...	...	...	...	...				
<i>Encrinurus punctatus</i> , Brünnich	...	...	...	...	...	...	...		*		
— <i>variolaris</i> , Brong.	...	...	...	...	...	...	...		*		
<i>Erinnys venulosa</i> , Salt.	...	*	...	...	...	...	...		*		
<i>Euloma?</i> <i>monile</i> , Hall	...	...	...	*	...	...	...				
<i>Eurypterus lanceolatus</i> , Salt.	...	...	...	...	...	...	...				
<i>Harpes Doranni</i> , Portl.	...	...	...	...	...	...	*				*
— <i>Flanagani</i> , Portl.	...	...	...	...	...	...	*				
<i>Holocephalina primordialis</i> , Salt.	...	*	...	...	...	...	*				
<i>Homalonotus bisulcatus</i> , Salt.	...	...	...	...	...	...	*				
— <i>delphino-cephalus</i> , Green	...	...	...	...	...	...	...			*	
<i>Hymenocaris vermicauda</i> , Salt.	...	...	*	...	...	...	...				
<i>Illoenopsis?</i> <i>acuticauda</i> , Hicks	...	...	...	...	*	...	...				
<i>Illoenus Barriensis</i> , Murch.	...	...	...	...	...	...	...			*	
— <i>Bowmanni</i> , Salt.	...	...	...	...	...	...	*				
— <i>Davisii</i> , Salt.	...	...	...	...	...	...	*				
— <i>Hughesii</i> , Hicks	...	...	...	...	*	...	...				
— <i>perovalis</i> , Murch.	...	...	...	...	*	...	...				
— <i>Rosenbergi</i> , Eichw.	...	...	...	...	...	...	*				
<i>Leperditia Cambrensis</i> , Hicks	*	...	...	...	...	...	...				
<i>Lichas anglicus</i> , Beyr.	...	...	...	...	...	...	...			*	
— <i>bulbiceps</i> , Hall	...	...	...	...	...	...	*				
— <i>hibernicus</i> , Portl.	...	...	...	...	...	...	*				
— <i>laxatus</i> , McCoy	...	...	...	...	...	...	*				
<i>Lingulocaris lingulaecomis</i> , Salt.	...	...	...	*	*	...	...				
<i>Microdiscus punctatus</i> , Salt.	...	*	...	...	...	...	...				
<i>Neseuretus ramseyensis</i> , Hicks	...	...	...	*	...	...	...				
<i>Niobe Doveri</i> , Ether.	...	...	...	*	...	...	...				
— <i>Homfrayi</i> , Salt.	...	...	...	*	...	...	...				
— <i>menapiensis</i> , Hicks	...	...	...	*	...	...	...				
— <i>solvensis</i> , Hicks	...	...	...	*	...	...	...				
<i>Ogygia Buchii</i> , Brong.	...	...	...	...	...	*	...				
— <i>peltata</i> , Salt.	...	...	...	...	...	...	*				
— <i>scutatrix</i> , Salt.	...	...	...	*	...	...	...				
— <i>Selwynii</i> , Salt.	...	...	...	...	*	...	...				
<i>Olenus alatus</i> , Boeck	...	...	...	*	...	...	...				
— <i>cataractes</i> , Salt.	...	...	...	*	...	...	...				
— <i>micrurus</i> , Salt.	...	...	...	*	...	...	...				
— <i>Salteri</i> , Call.	...	...	...	*	...	...	...				
— <i>scarabocoides</i> , Wahl.	...	...	...	*	...	...	...				
<i>Palaeopyge Ramsayi</i> , Salt.	*	...	...	...	...	...	...				
<i>Parabolina (Olenus) spinulosa</i> , Wahl.	...	...	*	...	...	...	...				
<i>Paradoxides aurora</i> , Salt.	*	...	...	...	...	...	...				
— <i>Davidis</i> , Salt.	...	*	...	...	...	...	...				
— <i>Harknessi</i> , Hicks	*	...	...	...	...	...	...				

	Harlech	Menevian	Lingula Fl.	Tremadoc	Arenig and Llanvirn	Lower Bala	Middle Bala	Upper Bala	May Hill	Salopian	Downtonian
<i>Paradoxides solvensis</i> , Hicks M. S.	*										
<i>Peltocaris anatina</i> , Salt.	...	...	...	...	...	...	...	...	...	*	
— <i>aptychoides</i> , Salt.	...	...	...	...	...	...	...	...	*		
<i>Phacops apiculatus</i> , Salt.	...	...	...	...	...	...	*	*			
— <i>brevispina</i> , F. Schmidt	...	...	...	...	...	...	*	*			
— <i>Brongniartii</i> , Portl.	...	...	...	...	...	...	*	*			
— <i>caudatus</i> , Brong.	...	...	...	...	...	...	*	*			
— <i>caudatus</i> var. <i>corrugatus</i> , Salt.	...	...	...	...	...	...	*	*		*	
— <i>conicophthalma</i> , Boeck	...	...	...	...	...	...	*	*		*	
— <i>Downingiae</i> , Murch.	...	...	...	...	...	...	*	*		*	
— <i>Eichwaldi</i> , F. Schmidt	...	...	...	...	...	...	*	*		*	
— <i>elegans</i> , Boeck and Sars	...	...	...	...	...	...	*	*		*	
— <i>eucentra</i> , Ang.	...	...	...	...	...	...	*	*		*	
— <i>imbricatus</i> , Ang.	...	...	...	...	...	...	*	*		*	
— <i>llanvirnensis</i> , Hicks	...	...	...	...	*	...	*	*		*	
— <i>Nicholsoni</i> , Salt.	...	...	...	...	*	...	*	*		*	
— <i>obtusicaudatus</i> , Salt.	...	...	...	...	...	...	*	*		*	
— <i>Stokesii</i> , M. Edw.	...	...	...	...	...	...	*	*		*	
— <i>torvus</i> , Edgell M. S.	...	...	...	...	...	...	*	*		*	
— <i>truncato-caudatus</i> , Portl.	...	...	...	...	...	*	*	*		*	
<i>Placoparia cambrensis</i> , Hicks	...	...	...	...	*	...	*	*		*	
<i>Plutonia Sedgwicki</i> , Hicks	*	...	...	...	...	...	*	*		*	
<i>Proetus latifrons</i> , McCoy	...	...	...	...	...	...	*	*		*	
— <i>Stokesii</i> , Murch.	...	...	...	...	...	...	*	*		*	
<i>Psiloecephalus inflatus</i> , Salt.	...	...	...	*	...	...	*	*		*	
— <i>innotatus</i> , Salt.	...	...	...	*	...	...	*	*		*	
<i>Pterygotus arcuatus</i> , Salt.	...	...	...	...	...	...	*	*		*	
— <i>Banksii</i> , Salt.	...	...	...	...	...	...	*	*		*	
— <i>bilobatus</i> , Salt.	...	...	...	...	...	...	*	*		*	
— <i>perornatus</i> , Salt.	...	...	...	...	...	...	*	*		*	
— <i>problematicus</i> , Ag.	...	...	...	...	...	...	*	*		*	
<i>Remopleurides dorso-spinifer</i> , Portl.	...	...	...	...	...	...	*	*		*	
— <i>Colbii</i> , Portl.	...	...	...	...	...	...	*	*		*	
— <i>radians</i> , Barr.	...	...	...	...	...	...	*	*		*	
<i>Slimonia acuminata</i> , Salt.	...	...	...	...	...	...	*	*		*	
— <i>punctata</i> , Salt.	...	...	...	...	...	...	*	*		*	
<i>Sphaerexochus mirus</i> , Beyr.	...	...	...	...	...	...	*	*		*	
— <i>calvus</i> , McCoy	...	...	...	...	...	...	*	*		*	
<i>Staurocephalus clavifrons</i> , Ang.	...	...	...	...	...	...	*	*		*	
— <i>globiceps</i> , Portl.	...	...	...	...	...	...	*	*		*	
— <i>unicus</i> , Wyv. Thom.	...	...	...	...	...	...	*	*		*	
<i>Stygina latifrons</i> , Portl.	...	...	...	...	...	...	*	*		*	
<i>Trinucleus concentricus</i> , Eaton	...	...	...	...	...	*	*	*		*	
— <i>Gibbsii</i> , Salt.	...	...	...	...	*	...	*	*		*	
— <i>Lloydii</i> , Murch.	...	...	...	...	*	*	*	*		*	
— <i>Murchisoni</i> , Salt.	...	...	...	...	*	...	*	*		*	
— <i>Ramsayi</i> , Hicks	...	...	...	...	*	...	*	*		*	
— <i>seticornis</i> , His.	...	...	...	...	...	...	*	*		*	
— <i>seticornis</i> var. <i>Bucklandi</i> , Barr.	...	...	...	...	...	...	*	*		*	
<i>Turrilepas Wrightianus</i> , De Kon.	...	...	...	...	...	...	...	...	*	*	

	Harlech	Menerian	Lingula Fl.	Tremadoc	Arenig and Llanvryn	Lower Bala	Middle Bala	Upper Bala	May Hill	Salopian	Downtonian
<i>Sub-kingdom. MOLLUSCA.</i>											
<i>Class. BRACHIOPODA.</i>											
<i>Athyris obovata</i> , Sow.	...	...	...	...	...	...	...	...	*		
<i>Atrypa hemisphaerica</i> , Sow.	...	...	...	...	...	...	...	...	*		
— <i>imbricata</i> , Sow.	...	...	...	...	...	...	...	...	*		
— <i>marginalis</i> , Dalm.	...	...	...	...	...	...	...	...	*		
— <i>reticularis</i> , Linn.	...	...	...	...	...	...	...	...	*		
<i>Chonetes lata</i> , Von Bach	...	...	...	...	...	...	...	...	*		*
<i>Cyrtia exporrecta</i> , Wahl.	...	...	...	...	...	...	...	...	*		
<i>Discina caerfaiensis</i> , Hicks	*	...	...	...	...	...	...	...	...	*	
— <i>rugata</i> , Sow.	...	...	...	...	...	...	...	...	...	*	
<i>Kutorgina cingulata</i> , Billings	...	...	*	...	...	...	...	...	...		
<i>Leptaena quinquecostata</i> , McCoy	...	...	...	...	...	...	...	...	*		
— <i>scissa</i> , Salt.	...	...	...	...	...	...	...	...	*		
— <i>sericea</i> , Sow.	...	...	...	...	...	...	...	...	*		
— <i>transversalis</i> , Wahl.	...	...	...	...	...	*	*	...	*	*	
<i>Lingula brevis</i> , Portl.	...	...	...	...	*	...	...	...	*		
— <i>canadensis</i> , Billings	...	...	...	...	...	*	...	...	...		
— <i>cornea</i> , Sow.	...	...	...	...	...	...	...	...	...		*
— <i>Lewisii</i> , Sow.	...	...	...	...	...	...	...	...	...	*	
— <i>ovata</i> , McCoy	...	...	...	...	...	...	*	...	...		
— <i>tenuigranulata</i> , McCoy	...	...	...	...	...	...	...	...	...		
<i>Lingulella Davisii</i> , McCoy	...	...	*	*	...	...	...	...	...		
— <i>lepis</i> , Salt.	...	...	*	*	*	...	...	...	...		
— <i>primaeva</i> , Hicks	*	...	*	*	...	...	...	...	...		
<i>Meristella crassa</i> , Sow.	...	...	...	...	...	...	...	...	*		
— <i>Circe</i> , Barr.	...	...	...	...	...	...	...	...	...	*	
— <i>tumida</i> , Dalm.	...	...	...	...	...	...	...	...	...	*	
<i>Obolella plumbea</i> , Salt.	...	...	...	...	*	...	...	...	...		
<i>Orthis actioniae</i> , Sow.	...	...	...	...	...	...	*	...	...		
— <i>alata</i> , Sow.	...	...	...	...	...	...	...	...	?		
— <i>alternata</i> , Sow.	...	...	...	...	...	...	*	...	...		
— <i>biforata</i> , Schloth.	...	...	...	...	...	...	...	*	...		
— <i>biloba</i> , Linn.	...	...	...	...	...	...	...	...	*	*	
— <i>calligramma</i> , Dalm.	...	...	...	...	...	...	*	...	*		
— <i>carausii</i> , Salt.	...	...	...	*	...	...	...	...	*		
— <i>confinis</i> , Salt.	...	...	...	...	...	*	...	...	...		
— <i>elegantula</i> , Dalm.	...	...	...	...	...	...	...	*	*	*	
— <i>fallax</i> , Salt.	...	...	...	...	...	...	*	...	...		
— <i>flabellulum</i> , Sow.	...	...	...	...	...	...	*	...	...		
— <i>hirnantensis</i> , McCoy	...	...	...	...	...	...	...	*	...		
— <i>insularis</i> , Eichw.	...	...	...	...	...	...	*	...	*		
— <i>lenticularis</i> , Dalm.	...	...	...	...	*	...	...	...	*		
— <i>lunata</i> , Sow.	...	...	...	...	...	...	...	...	...	...	*
— <i>menapiae</i> , Hicks	...	...	...	*	...	...	...	...	...		
— <i>monilifera</i> , McCoy	...	...	...	...	...	...	*	...	...		
— <i>plicata</i> , Sow.	...	...	...	...	...	...	...	...	*		
— <i>porcata</i> , McCoy	...	...	...	...	...	...	*	...	...		
— <i>protensa</i> , Sow.	...	...	...	...	...	...	...	*	*		
— <i>reversa</i> , Salt.	...	...	...	...	...	...	...	*	*		
— <i>sagittifera</i> , McCoy	...	...	...	...	...	...	...	*	...		
— <i>spiriferoides</i> , McCoy	...	...	...	...	...	...	*	...	...		

	Harlech	Menevian	Lingula Fl.	Tremadoc	Arenig and Llanvirn	Lower Bala	Middle Bala	Upper Bala	May Hill	Salopian	Downtonian
<i>Orthis testudinaria</i> , Dalm.	...	...	...	...	?	...	*	*			
— <i>turgida</i> , McCoy	...	...	...	...	...	*	*	*			
— <i>vespertilio</i> , Sow.	...	...	...	...	...	*	*	*			
<i>Pentamerus galeatus</i> , Dalm.	...	...	...	...	...	...	...	...	*		
— <i>globosus</i> , Sow.	...	...	...	...	...	...	...	...	*		
— <i>Knightii</i> , Sow.	...	...	...	...	...	...	...	...	*		
— <i>Knightii</i> var. <i>elongatus</i>	...	...	...	...	...	...	...	...	*		
— <i>linguifer</i> , Sow.	...	...	...	...	...	...	...	...	*		
— <i>oblongus</i> , Sow.	...	...	...	...	...	...	...	...	*		
— <i>undatus</i> , Sow.	...	...	...	...	...	...	...	...	*		
<i>Retzia Barrandei</i> , Dav.	...	...	...	...	...	...	...	...	*		
<i>Rhynchonella borealis</i> , Schloth.	...	...	...	...	...	...	...	...	*		*
— <i>cuneata</i> , Dalm.	...	...	...	...	...	...	...	...	*		
— <i>navicula</i> , Sow.	...	...	...	...	...	...	...	...	*		
— <i>nucula</i> , Sow.	...	...	...	...	...	...	...	...	*		*
— <i>Portlockiana</i> .	...	...	...	...	...	*	...	...	*		*
— <i>Wilsoni</i> , Sow.	...	...	...	...	...	...	...	...	*		
<i>Siphonotreta micula</i> , McCoy	...	...	...	...	...	*	...	...	...	*	
<i>Spirifera elevata</i> , Dalm.	...	...	...	...	...	...	...	...	...	*	
— <i>plicatella</i> , Linn.	...	...	...	...	...	...	...	...	...	*	
<i>Strophomena antiquata</i> , Sow.	...	...	...	...	...	...	*	...	...	...	
— <i>arenacea</i> , Salt.	...	...	...	...	...	...	*	...	...	...	
— <i>corrugatella</i> , Dav.	...	...	...	...	...	...	*	...	...	...	
— <i>depressa</i> , Dalm.	...	...	...	...	...	...	*	...	...	...	
— <i>euglypha</i> , His.	...	...	...	...	...	...	*	...	...	*	
— <i>expansa</i> , Sow.	...	...	...	...	...	...	*	...	...	...	
— <i>filosa</i> , Sow.	...	...	...	...	...	...	*	...	...	...	*
— <i>grandis</i> , Sow.	...	...	...	...	...	...	*	...	...	...	
— <i>pecten</i> , Linn.	...	...	...	...	...	...	*	...	*	...	
— <i>rhomboidalis</i> , Wahl.	...	...	...	...	...	...	*	...	*	...	
— <i>siluriana</i> , Dav.	...	...	...	...	...	...	*	...	*	...	
<i>Stricklandinia lens</i> , Sow.	...	...	...	...	...	...	...	...	*	...	
— <i>lirata</i> , Sow.	...	...	...	...	...	...	...	...	*	...	
<i>Trematis corona</i> , Salt. M.S.	...	...	...	...	...	...	*	...	...	...	
<i>Class. CONCHIFERA.</i>											
<i>Ambonychia striata</i> , Sow.	...	...	...	...	...	...	...	...	...	*	
— <i>transversa</i> , Portl.	...	...	...	...	...	...	*	...	...	...	
<i>Arca Edmondiiformis</i> , McCoy	...	...	...	...	...	...	...	*	...	...	
<i>Avicula Danbyi</i> , McCoy	...	...	...	...	...	...	...	...	...	...	*
— <i>mira</i> , Barr.	...	...	...	...	...	...	...	...	...	*	
<i>Cardiola interrupta</i> , Broderip	...	...	...	...	...	...	...	...	...	*	
— <i>striata</i> , Sow.	...	...	...	...	...	...	...	...	...	*	
<i>Ctenodonta anglica</i> , D'Orb.	...	...	...	...	...	...	...	...	...	...	*
— <i>Hughesii</i> , Salt.	...	...	...	...	...	...	...	...	*	...	
— <i>menapiensis</i> , Hicks	...	...	...	*	...	...	...	...	...	...	
— <i>obliqua</i> , Portl.	...	...	...	...	...	...	*	...	...	...	
<i>Glyptarca primaeva</i> , Hicks	...	...	...	*	...	...	...	...	...	...	
<i>Grammysia cingulata</i> , His.	...	...	...	...	...	...	*	...	...	*	*
<i>Modiolopsis expansa</i> , Portl.	...	...	...	...	...	...	...	...	...	...	
— <i>modiolaris</i> , Conrad	...	...	...	...	...	...	...	*	...	...	
— <i>planata</i> , Salt.	...	...	...	...	...	...	...	...	...	...	*

	Harlech	Menevan	Lingula Fl.	Tremadoc	Arenig and Llanvirm	Lower Bala	Middle Bala	Upper Bala	May Hill	Salopian	Downtonian
<i>Modiolopsis ramseyensis</i> , Hicks	...	...	...	*	...	...	...	...	...	...	...
<i>Mytilus mimus</i> , Salt.	...	...	...	...	...	...	...	...	...	...	...
— <i>mytilimeris</i> , Conrad	...	...	...	...	...	...	...	...	...	...	...
— <i>simillimis</i> , McCoy	...	...	...	...	...	...	*	...	...	*	...
<i>Orthonota amygdalina</i> , Sow.	...	...	...	...	...	...	...	...	...	...	...
— <i>truncata</i> , McCoy	...	...	...	...	...	...	...	...	...	...	...
<i>Palaearca socialis</i> , Salt.	...	...	...	*	...	...	...	...	...	...	...
<i>Pterinea demissa</i> , Conrad	...	...	...	...	...	...	...	...	...	...	...
— <i>retroflexa</i> , Wahl.	...	...	...	...	...	...	...	*	...	...	...
— <i>subfalcata</i> , Conrad	...	...	...	...	...	...	...	...	...	...	...
— <i>Sowerbyi</i> , McCoy	...	...	...	...	...	...	...	...	...	...	...
<i>Redonia anglica</i> , Salt.	...	...	...	*	...	...	...	...	...	...	...
<i>Ribeiria complanata</i> , Salt.	...	...	...	*	...	...	...	...	...	...	...
<i>Class GASTEROPODA.</i>											
<i>Acrocnlia euomphaloides</i> , McCoy	...	...	...	...	...	...	...	...	...	*	...
— <i>haliotis</i> , Sow.	...	...	...	...	...	...	...	...	...	*	...
<i>Cyclonema corallii</i> , Sow.	...	...	...	...	...	...	...	...	...	...	...
— <i>crebristria</i> , McCoy	...	...	...	...	...	...	...	...	*	...	...
— <i>trimarginalis</i> , Eichw.	...	...	...	...	...	...	*	...	...	...	...
<i>Euomphalus funatus</i> , Sow.	...	...	...	...	...	...	...	...	...	...	...
— <i>rugosus</i> , Sow.	...	...	...	...	...	...	...	...	...	...	...
— <i>sculptus</i> , Sow.	...	...	...	...	...	...	...	...	...	...	...
<i>Holopea concinna</i> , McCoy	...	...	...	...	...	...	...	*	...	...	...
<i>Holopella gracilior</i> , McCoy	...	...	...	...	...	...	...	...	...	...	...
— <i>gregaria</i> , Sow.	...	...	...	...	...	...	...	...	...	...	...
<i>Macrocheilus pupa</i> , Salt.	...	...	...	...	...	...	...	...	*	...	...
<i>Murchisonia angulata</i> , Sow.	...	...	...	...	...	...	...	...	*	...	...
— <i>Lloydii</i> , Sow.	...	...	...	...	...	...	...	...	*	...	...
— <i>sulcata</i> , McCoy	...	...	...	...	...	...	...	...	*	...	...
— <i>torquata</i> , McCoy	...	...	...	...	...	...	...	...	...	...	...
<i>Ophileta compacta</i> , Salt.	...	...	...	...	*	*	...	...	...	...	...
<i>Patella Saturni</i> , Goldf.	...	...	...	...	...	...	*	...	...	...	...
<i>Platyschisma helictes</i> , Sow.	...	...	...	...	...	...	...	...	...	...	...
<i>Pleurotomaria balteata</i> , Phill.	...	...	...	...	...	...	...	...	*	...	...
— <i>Bechei</i> .	...	...	...	...	...	...	...	...	...	...	...
<i>Class. HETEROPODA.</i>											
<i>Bellerophon arfonensis</i> , Salt.	...	...	...	*	...	...	...	...	...	...	...
— <i>dilatatus</i> , Sow.	...	...	...	...	...	...	...	...	*	...	...
— <i>expansus</i> , Sow.	...	...	...	...	...	...	...	...	...	...	...
— <i>multistriatus</i> , Salt.	...	...	...	*	*	...	...	...	...	...	...
— <i>perturbatus</i> , Sow.	...	...	...	...	*	*	...	...	...	...	...
— <i>ramseyensis</i> , Hicks	...	...	...	*	...	...	...	...	...	...	...
— <i>shinetonensis</i> , Call.	...	...	...	*	...	...	...	...	...	...	...
— <i>trilobatus</i> , Sow.	...	...	...	...	...	...	*	...	...	...	...
— <i>ventriculus</i>	...	...	...	...	...	...	...	...	...	...	...
— <i>wenlockensis</i> , Sow.	...	...	...	...	...	...	...	...	...	*	...
<i>Maclurea Loganii</i> , Salt.	...	...	...	...	...	*	...	...	...	...	...
— <i>Peachii</i> , Salt.	...	...	...	*	...	...	...	...	...	...	...

[illegible]

	Harlech	Menevian	Lingula Fl.	Tremadoc	Arenig and Llanvirn	Lower Bala	Middle Bala	Upper Bala	May Hill	Salopian	Downtonian
<i>Diplograptus foliaceus</i> , Murch.	...	...	...	...	*	...	...	...	*		
— <i>folium</i> , Barr.	...	...	...	...	...	...	...	...	*		
— <i>Hughesii</i> , Nich.	...	...	...	...	...	...	...	...	*		
— <i>mucronatus</i> ?	...	...	...	...	...	*	...	...	*		
— <i>palmeus</i> , Barr.	...	...	...	...	...	...	...	...	*		
— <i>pristis</i> , His.	...	...	...	...	...	...	*	...	*		
<i>Glossograptus Hincksi</i> , Hopk.	...	...	...	...	...	*	...	...	?		
<i>Graptolithus</i> ? <i>avus</i> , Barr.	...	...	...	...	*	...	...	...	...		
<i>Loganograptus Logani</i> , Hall	...	...	...	...	*	...	...	...	...		
<i>Monograptus Becki</i> , Barr.	...	...	...	...	...	...	...	...	*		
— <i>bohemicus</i> , Barr.	...	...	...	...	...	...	...	...	*	*	
— <i>Clingani</i> , Carr.	...	...	...	...	...	...	...	...	*	*	
— <i>clintonensis</i> , Barr.	...	...	...	...	...	...	...	...	*	*	
— <i>colonus</i> , Barr.	...	...	...	...	...	...	...	...	*	*	
— <i>convolutus</i> , His.	...	...	...	...	...	...	...	...	*	*	
— <i>convolutus</i> var. <i>Coppingeri</i> , Eth.	...	...	...	...	...	...	...	...	*	*	
— <i>crispus</i> , Lapw.	...	...	...	...	...	...	...	...	*	*	
— <i>cultellus</i> , Törnq.	...	...	...	...	...	...	...	...	*	*	
— <i>cyphus</i> , Lapw.	...	...	...	...	...	...	...	...	*	*	
— <i>dubius</i> , Suess.	...	...	...	...	...	...	...	...	*	*	
— <i>fimbriatus</i> , Nich.	...	...	...	...	...	...	...	...	*	*	
— <i>Flemingii</i> ?	...	...	...	...	...	...	...	...	*	*	
— <i>gregarius</i> , Lapw.	...	...	...	...	...	...	...	...	*	*	
— <i>Hisingeri</i> , Carr.	...	...	...	...	...	...	...	...	*	*	
— <i>jaculum</i> , Lapw.	...	...	...	...	...	...	...	...	*	*	
— <i>Linnarssoni</i> , Tullb.	...	...	...	...	...	...	...	...	*	*	
— <i>lobiferus</i> , McCoy	...	...	...	...	...	...	...	...	*	*	
— <i>Nilssoni</i> , Barr.	...	...	...	...	...	...	...	...	*	*	
— <i>nodifer</i> , Törnq.	...	...	...	...	...	...	...	...	*	*	
— <i>priodon</i> , Bronn.	...	...	...	...	...	...	...	...	*	*	
— <i>rhynchophorus</i> , Linnrs.	...	...	...	...	...	...	...	...	*	*	
— <i>riocartonensis</i> , Lapw.	...	...	...	...	...	...	...	...	*	*	
— <i>Roemeri</i> , Barr.	...	...	...	...	...	...	...	...	*	*	
— <i>runcinatus</i> , Lapw.	...	...	...	...	...	...	...	...	*	*	
— <i>scanicus</i> , Tullb.	...	...	...	...	...	...	...	...	*	*	
— <i>Sedgwicki</i> , Portl.	...	...	...	...	...	...	...	...	*	*	
— <i>spinigerus</i> , Nich.	...	...	...	...	...	...	...	...	*	*	
— <i>testis</i> , Barr.	...	...	...	...	...	...	...	...	*	*	
— <i>triangulatus</i> , Harkn.	...	...	...	...	...	...	...	...	*	*	
— <i>turriculatus</i> , Barr.	...	...	...	...	...	...	...	...	*	*	
— <i>uncinatus</i> , Tullb.	...	...	...	...	...	...	...	...	*	*	
— <i>vomerinus</i> , Nich.	...	...	...	...	...	...	...	...	*	*	
<i>Phyllograptus angustifolius</i> , Hall	...	...	...	...	*	...	...	...	...	*	
— <i>densus</i> , Törnq.	...	...	...	...	*	...	...	...	...	*	
— <i>typus</i> , Hall	...	...	...	...	*	...	...	...	...	*	
<i>Rastrites Linnaei</i> , Barr.	...	...	...	...	...	...	...	...	*	*	
— <i>maximus</i> , Carr.	...	...	...	...	...	...	...	...	*	*	
— <i>peregrinus</i> , Barr.	...	...	...	...	...	...	...	...	*	*	
<i>Retiolites Geinitzianus</i> , Barr.	...	...	...	...	...	...	...	...	...	*	
<i>Tetragraptus bryonoides</i> , Hall	...	...	...	...	*	...	...	...	...	*	
— <i>quadribrachiatus</i> , Hall	...	...	...	...	*	...	...	...	...	*	

	Harlech	Menevian	Lingula Fl.	Tremadoc	Arenig and Llanvirn	Lower Bala	Middle Bala	Upper Bala	May Hill	Salopian	Downtonian
<i>Dalmanites socialis</i> , Barr.	...	...	...	...	*						
— <i>proeva</i> , Barr.	...	...	...	...		*					
<i>Darwinia speciosa</i> , Dybowski	...	...	...	...							
<i>Deiphon Forbesi</i> , Barr.	...	...	...	...						*	
— <i>laevis</i> , Ang.	...	...	...	...						*	
<i>Dikellocephalus dicraeura</i> , Ang.	...	...	...	*							
— <i>magnificus</i> , Billings	...	...	...	*							
— <i>megalops</i> , Bill.	...	...	...	*							
— <i>Oweni</i> , Bill.	...	...	...	*							
— <i>planifrons</i> , Bill.	...	...	...	*							
<i>Dindymene Frederici-Augusti</i> , Barr.	...	...	...		*		*				
<i>Dionide formosa</i> , Barr.	...	...	...		*		*				
<i>Discinocaris Brouniana</i> , Woodw.	...	...	...		*		*		*		
<i>Ellipsocephalus Hoffi</i> , Schloth.	...	*	...								
<i>Encrinurus laevis</i> , Ang.	...	...	...							*	
— <i>multisegmentatus</i> , Portl.	...	...	...				*		*	*	
— <i>punctatus</i> , Brünnich	...	...	...				*		*	*	*
— <i>Seebachi</i> , Schmidt	...	...	...				*		*	*	*
— <i>sp.</i>	...	...	...				*		*	*	*
<i>Erinnys (Harpides) Grimmi</i> , Barr.	...	...	...	*							
— () <i>rugosa</i> , Sars & Boeck	...	...	...	*							
<i>Euloma laevis</i> , Ang.	...	...	...	*							
— <i>ornatum</i> , Ang.	...	...	...	*							
<i>Eurycare camuricorne</i> , Ang.	...	...	*								
<i>Eurypterus Fischeri</i> , Eichw.	...	...	...								*
— <i>remipes</i> , Dekay	...	...	...								*
<i>Harpes antiquatus</i> , Barr.	...	...	...		*						*
— <i>venulosus</i> , Barr.	...	...	...							*	*
— <i>Wegelini</i> , Ang.	...	...	...				*		*	*	*
<i>Hemiaspis rugosus</i> , Nieszk.	...	...	...								*
<i>Homalonotus delphinocephalus</i> , Green	...	...	...						*	*	
— <i>medius</i> , Barr.	...	...	...				*				
— <i>rarus</i> , Barr.	...	...	...		*						
— <i>rhinotropis</i> , Ang.	...	...	...							*	
<i>Hydrocephalus carens</i> , Barr.	...	*	...								
<i>Illoenus advena</i> , Barr.	...	...	...		*						
— <i>Bowmanni</i> , Salt.	...	...	...		*		*				
— <i>Conradi</i> , Bill.	...	...	...		*						
— <i>crassicauda</i> , Wahl.	...	...	...		*						
— <i>giganteus</i> , Burm.	...	...	...		*						
— <i>globosus</i> , Bill.	...	...	...		*						
— <i>Katzeri</i> , Barr.	...	...	...		*						
— <i>limbatus</i> , Linnrs.	...	...	...		*	*					
— <i>Panderi</i> , Barr.	...	...	...		*						
— <i>Roemeri</i> , Volb.	...	...	...					*			
— <i>Schmidt</i> , Volb.	...	...	...			*					
— <i>Volborthi</i>	...	...	...							*	
<i>Isocolus Sjöegreni</i> , Ang.	...	...	...							*	
<i>Leperditia Angelini</i> , Schmidt	...	...	...								*
— <i>Keyserlingi</i> , Schmidt	...	...	...						*		
— <i>Schmidt</i> , Kolm.	...	...	...						*		
<i>Lichas celorhin</i> , Ang.	...	...	...		*						

	Harlech	Menerian	Lingula Fl.	Tremadoc	Arenig and Llanvirn	Lower Bala	Middle Bala	Upper Bala	May Hill	Salopian	Downtonian
<i>Lichas dalecarlica</i> , Ang.	...	...	...	...	...	...	*	...	...	...	
— <i>Haueri</i> , Barr.	...	...	...	...	...	...	*	...	...	...	*
— <i>laxatus</i> , McCoy	...	...	...	...	...	...	*	...	...	...	
— <i>margaritifera</i> , Nieszk.	...	...	...	...	...	...	*	...	...	...	
— <i>palmata</i> , Barr.	...	...	...	...	...	...	*	...	...	*	
<i>Liostracus aculeatus</i> , Ang.	...	*	...	...	...	...	...	...	...	...	
<i>Megalaspis limbata</i> , Ang.	...	...	...	...	*	...	...	...	...	...	
— <i>planilimbata</i> , Ang.	...	...	...	...	*	...	...	...	...	...	
— <i>Heros</i> , Dalm.	...	...	...	...	*	...	...	...	...	...	
<i>Microdiscus</i>	...	*	...	...	...	...	...	...	...	...	
<i>Nileus armadillo</i> , Dalm.	...	...	...	...	*	...	...	...	...	...	
<i>Niobe frontalis</i> , Dalm.	...	...	...	...	*	...	...	...	...	...	
<i>Ogygia Desmaresti</i> , Brong.	...	...	...	...	*	...	...	...	...	...	
— <i>desiderata</i> , Barr.	...	...	...	...	*	...	...	...	...	...	
<i>Olenus gibbosus</i> , Wahl.	...	...	*	...	...	...	...	...	...	...	
— <i>truncatus</i> , Bronn.	...	...	*	...	...	...	...	...	...	...	
<i>Parabolina spinulosa</i> , Ang.	...	...	...	...	...	...	...	...	...	...	
<i>Peltura scaraboeoides</i> , Wahl.	...	...	*	...	...	...	...	...	...	...	
<i>Paradoxides Bennetti</i> , Salt.	...	*	...	...	...	...	...	...	...	...	
— <i>bohemicus</i> , Barr.	...	*	...	...	...	...	...	...	...	...	
— <i>Davidis</i> , Salt.	...	*	...	...	...	...	...	...	...	...	
— <i>Forchhammeri</i> , Ang.	...	*	...	...	...	...	...	...	...	...	
— <i>lamellatus</i> , Hartt	...	*	...	...	...	...	...	...	...	...	
— <i>pradoanus</i> , Barr.	...	*	...	...	...	...	...	...	...	...	
— <i>spinosus</i> , Boeck.	...	*	...	...	...	...	...	...	...	...	
— <i>Tessini</i> , Brong.	...	*	...	...	...	...	...	...	...	...	
— (<i>Olenellus</i>) <i>Kjerulfi</i> , Linnrs.	...	*	...	...	...	...	...	...	...	...	
— () <i>Thompsoni</i> , Hall	...	*	...	...	...	...	...	...	...	...	
— () <i>Vermontanus</i> , Hall	...	*	...	...	...	...	...	...	...	...	
<i>Phacops atavus</i> , Barr.	...	...	...	...	*	...	...	...	...	...	
— <i>Bebryx</i>	...	...	...	...	*	...	...	...	...	...	
— <i>bucculenta</i> , Sjogr.	...	...	...	...	*	...	*	...	...	...	
— <i>callicephalus</i> , Hall	...	...	...	...	*	...	...	...	...	...	
— <i>caudatus</i> , Brong.	...	...	...	...	*	...	...	...	...	*	
— <i>conicophthalma</i> , Boeck.	...	...	...	...	*	...	*	...	...	*	
— <i>Downingia</i> , Murch.	...	...	...	...	*	...	...	...	...	*	
— <i>Dujardini</i> , Roualt	...	...	...	...	*	...	...	...	...	*	
— <i>Eichwaldi</i> , Schmidt	...	...	...	...	...	...	*	...	...	...	
— <i>elegans</i> , Boeck and Sars	...	...	...	...	...	...	...	*	...	...	
— <i>eucentra</i> , Ang.	...	...	...	...	...	...	...	*	...	...	
— <i>fecundus</i> , Barr.	...	...	...	...	...	...	...	...	...	...	*
— <i>limulus</i> , Hall	...	...	...	...	...	...	...	...	*	...	
— <i>maxima</i> , Schmidt	...	...	...	...	...	...	*	...	*	...	
— <i>mucronata</i> , Brong.	...	...	...	...	...	...	...	...	*	...	
— <i>Odini</i> , Eichw.	...	...	...	...	...	*	...	...	...	...	
— <i>Odini</i> , var. <i>Itterensis</i>	...	...	...	...	...	*	...	...	...	...	
— <i>proaevus</i> , Emmr.	...	...	...	...	*	...	...	...	...	...	
— <i>socialis</i> , Vern.	...	...	...	...	*	...	...	...	...	...	
— <i>Volborthi</i> , Barr.	...	...	...	...	...	...	...	...	...	*	
— <i>Wesenbergensis</i> , Schmidt	...	...	...	...	...	...	*	...	...	...	
<i>Phillipsia parabola</i> , Barr.	...	...	...	...	...	...	*	*	...	...	
<i>Placoparia grandis</i> , Barr.	...	...	...	...	*	...	...	...	...	...	

	Harlech	Menervian	Lingula Fl.	Tremadoc	Arenig and Llanvirn	Lower Bala	Middle Bala	Upper Bala	May Hill	Salopian	Downtonian
Placoparia Tournemini, Roualt	...	...	...	...	*						
Zippei, Barr.	...	...	...	...	*						
Primitia brachynota, Schmidt.	...	...	...	...	...			*			
Proetus Alaricus, Bill.	...	...	...	...	...	*					
bohemicus, Barr.	...	...	...	...	...						*
brevifrons, Vern.	...	...	...	...	...			*		*	
concinnus, Dalm.	...	...	...	...	...					*	
latifrons, Nieszk.	...	...	...	...	...					*	
lepidus, Barr.	...	...	...	...	...					*	*
ramisulcatus, Nieszk.	...	...	...	...	...			*		*	*
superstes, Barr.	...	...	...	...	...					*	*
Pterygotus expectatus, Barr.	...	...	...	...	...					*	*
Ptychopyge lata, Ang.	...	...	...	...	*						
Remopleurides radians, Barr.	...	...	...	...	...		*				
sp.	...	...	...	...	...					*	
Sao hirsuta, Barr.	...	*									
Selenopleura brachymetopa, Ang.	...	*									
Sphaerexochus angustifrons, Ang.	...	...	...	...	...					*	
latens, Barr.	...	...	...	...	...		*			*	
mirus, Beyr.	...	...	...	...	...					*	
parvus, Bill.	...	...	...	...	*					*	
ultimus, Barr.	...	...	...	...	...						*
Sphaerocoryphe sp.	...	...	...	...	...			*			
granulata, Ang.	...	...	...	...	...					*	
Sphaerophthalmus (Olenus) alatus, Boeck	...	...	*	...	...					*	
Staurocephalus clavifrons, Ang.	...	...	...	...	...			*			
Murchisoni, Barr.	...	...	...	...	...					*	
Telephus fractus, Barr.	...	...	...	...	...		*				
Wegelini, Ang.	...	...	...	...	...		*				
Triarthrus Becki, Green	...	...	...	...	...	*	*	*			
Trinucleus concentricus Eaton (= ornatus, Barr.)	...	...	...	...	*	*	*				
Goldfussi, Barr.	...	...	...	...	*	*					
Pongerardi, Roualt	...	...	...	...	*						
Reussi, Barr.	...	...	...	...	*						
seticornis, His.	...	...	...	...	...		*				
Wahlenbergi, Roualt	...	...	...	...	...			*			
Turrilepas bohemicus, Barr.	...	...	...	...	*						
delicatulus, Barr.	...	...	...	...	...					*	
fraternus, Barr.	...	...	...	...	...		*				
folliculum, Barr.	...	...	...	...	*						
<i>Sub-kingdom. MOLLUSCA.</i>											
<i>Class. POLYZOA.</i>											
Vincularia megastoma, Eichw.	...	...	...	...	...	...	...	...	*		
<i>Class. BRACHIOPODA.</i>											
Athyris borealis, Bill.	...	...	...	...	...	*					
Headi, Bill.	...	...	...	...	...	*					
naviformis, Hall?	...	...	...	...	...				*		
? Portlockiana, Dav.	...	...	...	...	...					*	
Atrypa altijugata, Lindstr.	...	...	...	...	...					*	
hemisphaerica, Sow.	...	...	...	...	...				*		

	Harlech	Menevian	Lingula Fl.	Tremadoc	Arsick and Llanvira	Lower Bala	Middle Bala	Upper Bala	May Hill	Salopian	Downtonian
<i>Atrypa imbricata</i> , Dalm.	...	...	...	...	...	...	...	*	*	*	*
— <i>laevis</i> , Mather	...	...	...	...	...	...	...	*	*	*	*
— <i>marginalis</i> , Dalm.	...	...	...	...	...	...	...	...	...	...	...
— <i>obovata</i> , Sow.	...	...	...	...	...	...	...	...	...	...	...
— <i>reticularis</i> , Linn.	...	...	...	...	...	...	...	...	*	*	*
— <i>Sappho</i> , Barr.	...	...	...	...	...	...	...	...	*	*	*
<i>Camerella angulosa</i> , Törnq.	...	...	...	...	...	...	...	...	...	*	*
— <i>antiqua</i> , Bill.	...	...	*	...	...	...	...	...	...	...	...
— <i>longirostra</i> , Bill.	...	...	...	...	*	...	...	...	...	...	...
— <i>Panderi</i> , Bill.	...	...	...	...	*	...	...	...	...	...	...
— <i>varians</i> , Bill.	...	...	...	...	*	...	...	...	...	...	...
— <i>Volborthi</i> , Bill.	...	...	...	...	*	...	...	...	...	...	...
<i>Chonetes hostinensis</i> , Barr.	...	...	...	...	...	...	...	...	...	...	*
— <i>minimus</i> , Sow.	...	...	...	...	...	...	...	...	...	...	*
— <i>novellus</i> , Barr.	...	...	...	...	...	...	...	...	...	...	*
— <i>striatella</i> , Dalm.	...	...	...	...	...	...	...	...	...	...	*
<i>Dinobolus Davidsoni</i> , Salt.	...	...	...	...	...	...	...	...	...	...	...
— <i>Schmidtii</i> , Dav.	...	...	...	...	...	...	*	...	*	...	...
<i>Kutorgina cingulata</i> , Bill.	...	...	*	...	...	...	...	...	...	...	...
<i>Leptaena aquila</i> , Barr.	...	...	...	...	...	...	*	...	...	...	...
— <i>Lewisii</i>	...	...	...	...	...	...	...	...	...	...	*
— <i>nuntia</i> , Barr.	...	...	...	...	...	...	*	...	...	...	...
— <i>quinquecostata</i> , McCoy	...	...	...	...	...	...	*	...	...	...	...
— <i>Schmidtii</i> , Törnq.	...	...	...	...	...	...	*	...	...	*	...
— <i>sericea</i> , Sow.	...	...	...	...	*	*	*	...	...	...	...
— <i>transversalis</i> , Wahl.	...	...	...	...	*	*	*	...	...	*	...
<i>Lingula acuminata</i> , Conr.	...	...	*	*	...	...	...	...	...	*	...
— <i>antiqua</i> , Hall	...	...	*	...	...	...	...	...	...	...	...
— <i>canadensis</i> , Bill.	...	...	...	...	...	*	...	...	...	...	...
— <i>cornea</i> , Sow.	...	...	...	...	...	...	...	...	...	...	...
— <i>cuneata</i> , Hall	...	...	...	...	...	...	...	...	...	...	...
— <i>Eva</i> , Bill.	...	...	...	...	...	...	...	...	*	...	...
— <i>Feistmanteli</i> , Barr.	...	...	*	...	*	...	...	...	...	...	...
— <i>Lyelli</i> , Bill.	...	...	...	...	*	...	...	...	...	...	...
— <i>Mantelli</i> , Bill.	...	...	...	*	...	...	...	...	...	...	...
— <i>minima</i> , Sow.	...	...	...	...	...	...	...	...	...	...	...
— <i>quadrata</i> , Eichw.	...	...	...	...	...	...	...	...	...	...	*
<i>Lingulella prima</i> , Conr.	...	...	*	...	...	...	*	...	...	...	...
— <i>cf. prima</i> , Conr.	...	*	...	...	...	...	...	...	...	...	...
— <i>cf. Davisii</i> , McCoy	...	...	...	*	...	...	...	...	...	...	...
<i>Meristella crassa</i> , Sow.	...	...	...	...	...	...	...	...	*	*	...
— <i>Herculea</i> , Barr.	...	...	...	...	...	...	...	...	...	...	*
— <i>tumida</i> , Dalm.	...	...	...	...	...	...	...	...	...	...	...
<i>Obolella sagittalis</i> , Salt.	...	*	...	...	...	...	...	...	...	*	...
— <i>? nitens</i> , His.	...	...	...	...	...	...	...	...	...	...	...
<i>Obolus Apollinis</i> , Eichw.	...	...	*	...	...	...	*	...	...	...	...
— <i>siluricus</i> , Eichw.	...	...	...	*	...	...	...	...	...	...	...
— <i>? monilifer</i> , Linnrs.	*	...	...	...	...	...	...	...	...	...	...
<i>Orthis actoniae</i> , Sow.	...	...	...	...	...	...	*	...	...	...	...
— <i>argentea</i> , His.	...	...	...	...	...	...	*	...	...	...	...
— <i>Berthoisi</i> , Ronalt	...	...	...	...	*	...	...	...	...	...	...
— <i>biforata</i> , Schloth.	...	...	...	...	...	...	*	...	...	*	...

	Harlech	Menevian	Lingula Fl.	Tremadoc	Arenig and Llanvirn	Lower Bala	Middle Bala	Upper Bala	May Hill	Salopian	Downtonian
<i>Orthis bohémica</i> , Barr.	...	...	...	...	*						
— <i>borealis</i> , Bill.	...	...	...	...	*						
— <i>Bouchardi</i> , Vern.	...	...	...	...	*				*		
— <i>callactis</i> , Dalm.	...	...	...	...	*						
— <i>calligramma</i> , Dalm.	...	...	...	...	*	*	*				
— <i>concinna</i> , Lindstr.	...	...	...	...	*	*	*			*	
— <i>Davidsoni</i> , Vern.	...	...	...	...	*	*	*			*	
— <i>desiderata</i> , Barr.	...	...	...	*	*	*	*		*		
— <i>elegantula</i> , Dalm.	...	...	...	...	*	*	*		*	*	*
— <i>hybrida</i> , Sow.	...	...	...	...	*	*	*		*	*	*
— <i>insularis</i> , Eichw.	...	...	...	...	*	*	*		*	*	*
— <i>lenticularis</i> , Dalm.	...	...	*	...	*	*	*		*	*	*
— <i>lunata</i> , Sow.	...	...	...	...	*	*	*		*	*	*
— <i>lynx</i> , Eichw.	...	...	...	...	*	*	*	*	*	*	*
— <i>nodulosa</i> , Lindstr.	...	...	...	...	*	*	*		*	*	*
— <i>occidentalis</i> , Hall	...	...	...	...	*	*	*		*	*	*
— <i>parva</i> , Pander	...	...	...	...	*	*	*		*	*	*
— <i>porcata</i> , McCoy	...	...	...	...	*	*	*		*	*	*
— <i>Porcia</i> , Billings	...	...	...	...	*	*	*		*	*	*
— <i>Roemingeri</i> , Barr.	...	*	...	...	*	*	*		*	*	*
— <i>redux</i> , Dav.	...	...	...	...	*	*	*		*	*	*
— <i>rustica</i> , Eichw.	...	...	...	...	*	*	*		*	*	*
— <i>subquadrata</i> , Salt.	...	...	...	...	*	*	*		*	*	*
— <i>testudinaria</i> , Dalm.	...	...	...	...	*	*	*	*	*	*	*
— <i>vespertilio</i> , Sow.	...	...	...	...	*	*	*	*	*	*	*
<i>Orthisina adscendens</i> , Pander	...	...	...	...	*	*	*		*	*	*
— <i>concava</i> , Pahlen	...	...	...	...	*	*	*		*	*	*
— <i>festinata</i> , Billings	...	...	*	...	*	*	*		*	*	*
— <i>grandaeva</i> , Bill.	...	...	...	*	*	*	*		*	*	*
— <i>plana</i> , Pander	...	...	...	...	*	*	*		*	*	*
— <i>Schmidtii</i> , Pahl.	...	...	...	...	*	*	*		*	*	*
— <i>Verneuili</i> , var. <i>Wesenbergensis</i> , Pahl.	...	...	...	...	*	*	*		*	*	*
<i>Pentamerus borealis</i> , Eichw.	...	...	...	...	*	*	*		*	*	*
— <i>galeatus</i> , Dalm.	...	...	...	...	*	*	*		*	*	*
— <i>Knightii</i> , Sow.	...	...	...	...	*	*	*		*	*	*
— <i>linguifer</i> , Sow.	...	...	...	...	*	*	*		*	*	*
— <i>oblongus</i> , Sow.	...	...	...	...	*	*	*		*	*	*
— <i>occidentalis</i> , Hall	...	...	...	...	*	*	*		*	*	*
— <i>Coppingeri</i> , Eth.	...	...	...	...	*	*	*		*	*	*
<i>Parambonites aequirostris</i> , Pand.	...	...	...	...	*	*	*		*	*	*
— <i>gigas</i> , Schmidt	...	...	...	...	*	*	*		*	*	*
— <i>Ribeiro</i> , Sharpe	...	...	...	...	*	*	*		*	*	*
— <i>teretior</i> , Eichw.	...	...	...	...	*	*	*		*	*	*
— <i>ventricosa</i> , Kutorga	...	...	...	...	*	*	*		*	*	*
<i>Retzia Barrandei</i> , Dav.	...	...	...	...	*	*	*		*	*	*
— <i>Salteri</i> , Dav.	...	...	...	...	*	*	*		*	*	*
— <i>vesta</i> , Barr.	...	...	...	...	*	*	*		*	*	*
<i>Rhynchonella borealis</i> , Schloth.	...	...	...	...	*	*	*		*	*	*
— <i>canaliculata</i> , Dalm.	...	...	...	...	*	*	*		*	*	*
— <i>capax</i> , cour.	...	...	...	...	*	*	*		*	*	*
— <i>cuneata</i> , Dalm.	...	...	...	...	*	*	*		*	*	*

	Harlech	Menevan	Lingula Fl.	Tremadoc	Arenig and Llanvirn	Lower Bala	Middle Bala	Upper Bala	May Hill	Salopian	Downtonian
<i>Grammysia cingulata</i> His.	...	...	...	...	...	...	...	...	...	*	*
----- <i>cingulata</i> var. <i>triangulata</i> , Salt.	...	...	...	...	...	...	...	...	...	...	*
----- <i>rotundata</i> , Sow.	...	...	...	...	...	...	...	...	...	...	*
<i>Isocardia potens</i> , Barr.	...	...	...	...	...	...	...	...	...	...	*
<i>Lunulicardium bohemicum</i> , Barr.	...	...	...	...	...	...	...	...	...	...	*
<i>Megalomus canadensis</i> , Hall	...	...	...	...	...	...	...	...	...	...	*
<i>Modiolopsis carinata</i> , Hall	...	...	...	...	*	...	...	...	...	...	*
----- <i>modiolaris</i> , Conr.	...	...	...	...	...	*	...	...	...	...	*
----- <i>platyphylla</i> , Salt.	...	...	...	...	...	...	...	...	...	*	*
<i>Nucula bohémica</i> , Barr.	...	...	...	...	...	*	...	...	...	...	*
----- sp.	...	...	...	...	...	...	*	...	...	...	*
<i>Pterinea retroflexa</i> , His.	...	...	...	...	...	...	...	...	...	*	*
<i>Redonia bohémica</i> , Barr.	...	...	...	...	*	...	...	...	...	...	*
----- <i>Deshayesiana</i> , Vern.	...	...	...	...	*	...	...	...	...	...	*
<i>Ribeiria pholadiformis</i> , Sharpe	...	...	...	...	*	...	*	...	...	...	*
----- <i>Sharpei</i> , Barr.	...	...	...	...	...	*	...	...	...	...	*
<i>Vanuxemia Montrealensis</i> , Bill.	...	...	...	...	*	...	...	...	...	...	*
<i>Class. GASTEROPODA.</i>											
<i>Acroculia Niagaraensis</i> , Hall	...	...	...	...	...	...	...	...	...	...	*
<i>Capulus elegans</i> , Barr.	...	...	...	...	...	...	...	...	...	...	*
<i>Chiton bohemicus</i> , Barr.	...	...	...	...	...	...	...	...	...	...	*
<i>Cyclonema angulosum</i> , Lindstr.	...	...	...	...	...	...	...	...	...	...	*
----- <i>bilix</i> , Conr.	...	...	...	...	...	*	...	...	...	...	*
----- <i>Halliana</i> , Salt.	...	...	...	...	*	...	...	...	...	...	*
<i>Eunema carinatum</i> , Lindstr.	...	...	...	...	...	...	...	...	...	...	*
----- <i>dalecarlicum</i> , Lindstr.	...	...	...	...	...	...	...	...	...	...	*
----- <i>Erigone</i> , Bill.	...	...	...	...	*	...	...	...	...	...	*
<i>Euomphalus funatus</i> , Sow.	...	...	...	...	...	...	...	...	...	...	*
----- <i>obtusangulus</i> , Lindstr.	...	...	...	...	...	...	...	...	...	...	*
----- <i>sculptus</i> , Sow.	...	...	...	...	...	...	...	...	...	...	*
<i>Holopea concinna</i> , McCoy	...	...	...	...	...	...	...	*	...	...	*
----- <i>Guelphensis</i> , Bill.	...	...	...	...	...	...	...	...	...	...	*
<i>Loxonema Gaspensis</i> , Bill.	...	...	...	...	...	...	...	...	...	...	*
<i>Murchisonia cingulata</i> , His.	...	...	...	...	...	...	...	...	...	...	*
----- <i>gracilis</i> , Hall	...	...	...	...	*	...	...	...	...	...	*
----- <i>macrospira</i> , Hall	...	...	...	...	...	...	...	...	...	...	*
----- <i>Nieszkowskii</i> , Schmidt	...	...	...	...	...	...	...	*	...	...	*
----- <i>simulatrix</i> , Bill.	...	...	...	...	*	...	...	...	...	...	*
----- <i>Verneuli</i> , Barr.	...	...	...	...	...	...	...	...	...	...	*
<i>Ophileta compacta</i> , Salt.	...	...	*	*	...	...	...	...	...	...	*
<i>Pilidion bohemicum</i> , Barr.	...	...	...	...	...	...	...	...	...	...	*
----- <i>fastigiatum</i> , Barr.	...	...	...	...	...	...	...	...	...	...	*
<i>Platyceras cornutum</i> , His.	...	...	...	...	...	...	...	...	...	...	*
<i>Platystoma harpa</i> , Lindstr.	...	...	...	...	...	...	...	...	...	...	*
<i>Platyschisma helicites</i> , Sow.	...	...	...	...	...	...	...	...	...	...	*
<i>Pleurotomaria calyx</i> , Bill.	...	...	...	...	*	...	...	...	...	...	*
----- <i>elliptica</i> , His.	...	...	...	...	*	...	...	...	...	...	*
----- <i>solaroides</i> , Hall	...	...	...	...	...	...	...	...	...	...	*
----- <i>subconica</i> , Hall	...	...	...	...	*	...	...	...	...	...	*
<i>Subulites gigas</i> , Eichw.	...	...	...	...	...	...	*	...	...	...	*

	Harlech	Menevian	Lingula Fl.	Tremadoc	Arenig and Llanvirn	Lower Bala	Middle Bala	Upper Bala	May Hill	Satoplan	Downtonian
<i>Subulites elongatus</i> , Conr.	...	...	...	...	*						
_____ <i>elongatus</i> , Portl.?	...	...	...	...	*					*	
_____ <i>nitens</i> , Lindstr.	...	...	...	...	*					*	
_____ <i>ventricosus</i> , Hall	...	...	...	...						*	
<i>Trochonema carinata</i> , Bill.	...	...	...	*							
_____ <i>cf. umbilicata</i> , Hall	...	...	...	...				*			
<i>Triblydium cf. unguis</i> , Lindstr.	...	...	...	...				*			
<i>Turbo striatus</i> , Sow.	...	...	...	...					*		
<i>Class. HETEROPODA.</i>											
<i>Bellerophon angustatus</i> , Bill.	...	...	...	...	*					*	
_____ <i>bilobatus</i> , Sow.	...	...	...	...	*		*			*	
_____ <i>bohemicus</i> , Barr.	...	...	...	...							*
<i>Ecculiomphalus subuloides</i> , Barr.	...	...	...	...						*	
<i>Maclurea</i>	...	...	...	...		*					
_____ <i>helix</i> , Eichw.	...	...	...	...	*						
_____ <i>Logani</i> , Salt.	...	...	...	...	*						
_____ <i>magna</i> , Lesener	...	...	...	...	*						
_____ <i>matutina</i> , Hall	...	...	...	*							
_____ <i>neritoides</i> , Eichw.	...	...	...	...			*				
_____ <i>Normani</i>	...	...	...	*							
<i>Class. PTEROPODA.</i>											
<i>Theca (Hyalites) prima</i> , Barr.	...	*									
<i>Class. CEPHALOPODA.</i>											
<i>Asioceras canadense</i> , Bill.	...	...	...	...		*					
_____ <i>Murchisoni</i> , Barr.	...	...	...	...						*	
<i>Conoceras preposterum</i> , Barr.	...	...	...	...	*						
_____ <i>Linnarssoni</i> , Ang.	...	...	...	...	*						
<i>Cyrtoceras aequale</i> , Barr.	...	...	...	...							*
_____ <i>cornu-venatorium</i> , Ang.	...	...	...	...	*						
_____ <i>longitudinale</i> , Ang.	...	...	...	...						*	
_____ <i>pugio</i> , Barr.	...	...	...	...						*	
_____ <i>sociale</i> , Barr.	...	...	...	...						*	
<i>Discoceras convolvens</i> , His.	...	...	...	...	*						
<i>Gomphoceras bohemicum</i> , Barr.	...	...	...	...						*	
_____ <i>biconicum</i> , Barr.	...	...	...	...						*	
_____ <i>conulus</i> , Eichw.	...	...	...	...			*				
_____ <i>semiclausum</i> , Barr.	...	...	...	...						*	
<i>Goniatites bohemicus</i> , Barr.	...	...	...	...						*	
_____ <i>fecundus</i> , Barr.	...	...	...	...						*	
_____ <i>plebeius</i> , Barr.	...	...	...	...						*	
<i>Gyroceras tenue</i> , Barr.	...	...	...	...						*	
<i>Heroceras mirum</i> , Barr.	...	...	...	...						*	
<i>Igoceras enorme</i> , Lindstr.	...	...	...	...						*	
<i>Lituites antiquissimus</i> , Eichw.	...	...	...	...			*				
_____ <i>lituus</i> , Montf.	...	...	...	...	*						
<i>Nautilus vetustus</i> , Barr.	...	...	...	...							*
<i>Orthoceras Allumettense</i> , Bill.	...	...	...	*							*
_____ <i>annulatum</i> , Sow.	...	...	...	...					*		*

	Harlech	Menevian	Lingula Fl.	Tremadoc	Arenig and Llanvirn	Lower Bala	Middle Bala	Upper Bala	May Hill	Salopian	Downtonian
Orthoceras Becki, Hall	...	...	...	*	...	...	...	...	...	...	...
_____ bohemicum, Barr.	...	...	...	...	...	...	...	...	...	...	...
_____ canaliculatum, Sow.	...	...	...	...	...	...	...	...	*	...	...
_____ commune, Wahl.	...	...	...	...	*	...	...	...	...	...	...
_____ conicum, His.	...	...	...	...	*	...	...	...	...	...	...
_____ crebriseptum, Hall	...	...	...	...	...	*	...	...	...	...	...
_____ dulce, Barr.	...	...	...	...	...	...	...	...	...	*	*
_____ duplex, Wahl.	...	...	...	...	*	...	...	...	...	...	...
_____ equisetum, Barr.	...	...	...	...	...	...	...	...	...	...	*
_____ fenestratum, Eichw.	...	...	...	...	...	...	*	...	...	...	...
_____ funiforme, Ang.	...	...	...	...	...	...	...	...	...	*	...
_____ importunum, Barr.	...	...	...	...	...	*	...	...	...	...	...
_____ laqueatum, Hall	...	...	...	*	...	...	...	...	...	...	...
_____ leptaenarum, Ang.	...	...	...	...	...	...	...	...	...	*	...
_____ originale, Barr.	...	...	...	...	...	...	...	...	...	...	*
_____ pseudo-calameum, Barr.	...	...	...	...	...	...	...	...	...	...	*
_____ redux, Barr.	...	...	...	...	...	...	...	...	...	...	*
_____ Schmidtii, Boll.	...	...	...	...	...	...	...	...	...	...	*
_____ seps, Eichw.	...	...	...	...	...	...	*	...	...	...	...
_____ styloideum, Barr.	...	...	...	...	...	...	...	...	...	*	...
_____ subannulare, Münst.	...	...	...	...	...	...	...	...	...	...	*
_____ turris, Ang.	...	...	...	...	...	...	...	...	...	*	...
_____ undulato-zonatum, Ang.	...	...	...	...	*	...	...	...	...	...	...
_____ vaginatum, Schloth.	...	...	...	...	*	...	...	...	...	...	...
_____ vertebrale, Eichw.	...	...	...	...	...	*	*	...	...	...	...
_____ Wegelini, Ang.	...	...	...	...	...	...	...	...	...	*	...
Piloceras canadense, Bill.	...	...	...	*	...	...	...	...	...	...	...
_____ Wortheni, Bill.	...	...	...	*	...	...	...	...	...	...	...
Phragmoceras Broderipi, Barr.	...	...	...	...	...	...	...	...	...	...	*
Trochoceras cornu-arietis, Sow.	...	...	...	...	...	...	*	...	...	...	...
_____ tardum, Barr.	...	...	...	...	...	...	...	...	...	...	*
_____ transiens, Barr.	...	...	...	...	...	...	...	...	...	...	*
<i>Sub-kingdom. VERTEBRATA.</i>											
<i>Class. PISCES.</i>											
Asteracanthus bohemicus, Barr.	...	...	...	...	...	...	...	...	...	...	*
Coccosteus Agassizi, Barr.	...	...	...	...	...	...	...	...	...	...	*
_____ primus, Barr.	...	...	...	...	...	...	...	...	...	...	*
Cheiracanthus bohemicus, Barr.	...	...	...	...	...	...	...	...	...	...	*
Ctenacanthus bohemicus, Barr.	...	...	...	...	...	...	...	...	...	...	*

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